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Geology of the Ardoch Area Frontenac County

by
L. Pauk

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Foreword

The Ardoch Area metasedimentary rocks host quartz and quartz dolomite veins that contain gold, silver, copper, lead, and zinc mineralization. Uranium and molybdenum occur in pegmatite dikes and veins. Industrial mineral commodities present in the area include mica, quartz, feldspar, tremolite, and kyanite.

Until 1980, the geological map coverage was at a reconnaissance level. The detailed mapping of the Ardoch Area is part of an ongoing program in this part of the Grenville Province and its primary aim is to provide a more effective basis for determining the mineral potential of the region and for guiding exploration. The study will also provide insight into the geological evolution of a larger area. Together with other detailed projects, it will eventually lead to a fuller understanding of the mineralization environments of the region and to a regional synthesis of the Precambrian geology of southeastern Ontario.

V.G. Milne
Director
Ontario Geological Survey

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GEOLOGICAL MAP (back pocket)

Map 2514 (coloured)—Ardoch Area, Frontenac County.
Scale 1:31 680.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the
Ardoch Area
Frontenac County

L. Pauk

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Abstract

The Ardoch map area covers about 250 km^2, mostly in Clarendon and Palmerston Townships, and is located 50 km west of Perth in Frontenac County. The area forms part of the Central Metasedimentary Belt of the Grenville Province.

Metavolcanics and metasediments of the Grenville Supergroup, and plutonic complexes of trondhjemitic and granitic composition are the major rock types underlying the area. Mafic intrusions are represented by a small stock of gabbro-diorite composition and diabasic dikes and sills. The oldest rocks in the area are Hermon Group metavolcanics which range in composition from basalt to rhyodacite. Metasedimentary rocks comprising clastic siliceous gneisses, carbonate metasediments, and minor calc-silicate gneisses and schists may be correlative with the Mayo Group.

Resting unconformably on the Hermon and Mayo Groups are clastic metasediments of the Flinton Group. These comprise carbonate, siliceous, pelitic, mafic, and conglomeratic metasediments and represent a sedimentary facies change from a low energy to a higher energy depositional environment.

The Northbrook Batholith, a pluton of trondhjemitic composition, and the granitic Abinger Pluton were emplaced into the metavolcanic and metasedimentary strata of the Hermon and Mayo Groups before the deposition of the Flinton Group. Extensive mid to late tectonic pegmatite dikes and sills form a prominent part of the bedrock within, and in the border zones, of the plutonic bodies.

The whole sequence, including plutons and younger metasediments of the Flinton Group, was metamorphosed and folded into a series of antiforms and synforms with northeast trending axes.

Amphibolite facies metamorphism has occurred throughout the area and the pressure-temperature gradient increases in a northeasterly direction.

Mineral exploration in the past has been concentrated in the clastic siliceous and carbonate metasedimentary units, where the principal gold discoveries were made in the area, between the villages of Fernleigh and Little Green Lake. More recently, exploration has focused on uranium mineralization associated with the pegmatites in the Cross Lake area. Also, potential for copper, zinc, and lead mineralization may exist in the map area.

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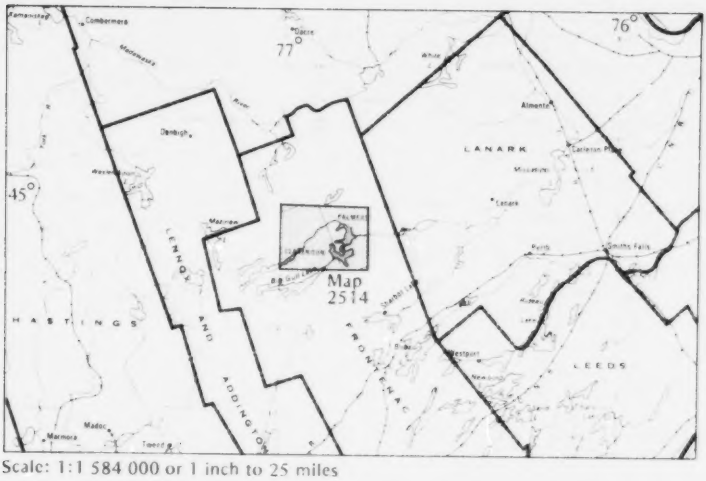

Scale: 1:1 584 000 or 1 inch to 25 miles

Figure 1. *Key map showing location of the Ardoch Area.*

Résumé

La région de Ardoch représentée sur la carte couvre près de 250 km², essentiellement répartis entre les cantons de Clarendon et de Palmerston, et se situe à 50 km à l'ouest de Perth dans le comté de Frontenac. La région fait partie de la ceinture centrale de roches sédimentaires partiellement métamorphisées de la province de Grenville.

Les roches volcaniques et les roches sédimentaires partiellement Métamorphisées du super-groupe de Grenville, les complexes plutoniques de composition trondhjémitique et granitique sont les principaux types de roches sous-jacentes dans cette région. Les intrusions mafiques sont représentées par un petit amas composé de gabbro-diorite et de filons et filons-couches diabasiques. Les roches les plus anciennes de la région sont les roches volcaniques partiellement métamorphisées du groupe Hermon dont la composition varie du basalt à la rhyodacite. Les roches sédimentaires partiellementmétamorphisées contenant des gneiss siliceux calstiques, des roches sédimentairs partiellements métamorphisées de carbonate, et quelques gneiss et schistes calcaires-siliceux correspondent peut-être au groupe Mayo.

Les roches sédimentaires partiellement métamorphisées clastiques du groupe Flinton présentent une discordance avec les groupes Hermon et Mayo sur lesquels elles s'appuient. Elles sont composées de roches sédimentaires partiellement métamorphisées conglomératiques, mafiques, pélitiques, siliceuses et carbonatées qui représentent un changement de faciès sédimentaire passé d'un environnement de dépôts énergétiques faible àun environnement plus élevé.

Le massif de Northbrook, pluton de composition trondhjémitique, et le pluton granitique d'Abinger étaient présents dans les couches de roches volcaniques et sédimentaires partiellement métamorphisées des groupes Hermon et Mayo avant le dépôt due groupe Flinton. De vastes filons et filons-couches moyens à tardifs de pegmatite tectonique forment une partie saillante des roches de couverture que l'on trouve à l'intérieur, et à la limite, des formations plutoniques.

Introduction

AREA, LOCATION, ACCESS

The Ardoch Area is in Frontenac County and includes parts of Clarendon and Palmerston Townships and a small area in Miller Township.

The map area covers about 250 km^2 and lies between Latitudes 44°52′30″ and 45°00′N and Longitudes 76°45′ and 77°00′W. The villages of Plevna and Fernleigh are located in the western part of the map area and the village of Ardoch is almost in the middle of the map area.

FIELD WORK

Geologic mapping of the Ardoch Area, at a scale of 1 inch to 1/4 mile, or 1:15 840, was carried out by the author and her assistants during the summer of 1980. The field maps were prepared on base maps produced by the Cartography Unit, Ministry of Natural Resources, from the National Topographic Series provisional map 31C/15. Mapping was done by pace and compass traverse lines run approximately 400 to 600 m apart and at right angles to the strike. The geological data were plotted on acetate overlays plotted over air photographs of 1:15 840 scale and transferred onto a base map of the same scale. Detailed examination was carried out over the areas around old mine workings, properties, and known occurrences of metallic minerals. A scintillometer was used in the field mainly in the Cross Lake (also known as Crotch Lake) area to detect and assess the uranium mineralization.

ACKNOWLEDGMENTS

The author was assisted in the field by C. A. Crosby, G. Mannard, W. Millar, and V. Morelli. C.A. Crosby and G. Mannard carried out independent traverses in some parts of the area.

Many residents in the area, too numerous to name individually, were helpful in many ways and the author would like to express appreciation to all. The author would like to thank Dr. J. M. Moore Jr. of the Department of Geology, Carleton University, Ottawa for discussing several aspects of the geology, and of the Flinton Group in particular. The author thanks Dr. B. L. Smith, for a fruitful discussion of the structural problems of the area. The author is also very indebted to M. Ghandikota, Review Geologist, Ontario Geological Survey, Toronto, for editorial advice and valuable contributions to the section on "Economic Geology".

PREVIOUS GEOLOGICAL WORK AND PROSPECTING ACTIVITY

Ells (1904) examined some parts of the map area along the roads and canoe routes as a part of the Geological Survey of Canada program to map the area south of the Ottawa River. He described granitic gneisses in the northwestern and southeastern parts of the map area and marble bands, hornblende schist, and rusty gneisses in between. He also mentioned the presence of a slaty conglomerate in the Ompah area and its similarity to the Kaladar conglomerate.

Miller and Knight (1914) mapped the northeastern part of the map area (Ompah area) and suggested the presence of an unconformity between the conglomerate and the Grenville limestone, and classified the conglomerate with the Hastings Series.

Systematic geological mapping of Clarendon, Palmerston, and a few adjacent townships was first carried out by Smith (1956), between 1949 and 1951, at a scale of 1 inch to 1 mile. Smith (1956) outlined the major structural and lithological units and described the unconformity between the quartzite metaconglomerate and the underlying older metasediments. Smith also recognized the Fernleigh-Clyde Fault which separates the younger, highly deformed series to the north of the fault from the older, less deformed series to the south.

Hewitt (1956) included the southeastern part of the map area, south of the Fernleigh-Clyde Fault, as a part of the Kaladar-Dalhousie Trough and considered the series north of the Fernleigh-Clyde Fault, with the metaconglomerate at the base, to be younger.

The present study area covers part of the region included in the compilation of the Madoc-Gananoque area by Hewitt (1964).

Moore (1967) described the angular unconformity between the metavolcanics+marble and the younger Flinton Group pelitic schist + metaconglomerate series, extending from Bishop Corners northeasterly into the Ardoch Area. He outlined the metamorphic zonation based on the progressive changes of mineral assemblages in the pelitic schists.

Lumbers (1967) outlined a regional stratigraphic succession consisting of an older, predominantly metavolcanic Hermon Group and a younger predominantly carbonate and clastic metasedimentary Mayo Group. The metavolcanics in the map area were correlated with the lower part (Tudor Formation) of the Hermon Group.

In 1972, Moore and Thompson assigned the succession of clastic metasedimentary rocks, which overlies the older metavolcanic and metasedimentary rocks, to the Flinton Group. They distinguished four formations within the Flinton Group and outlined the structure and stratigraphic succession of the Fernleigh and Ompah Synclines.

Sethuraman and Moore (1973) divided the metavolcanic rocks between Bishop Corners (a village about 14 km west of the map area) and Donaldson (a village about 1 km east of the northeastern boundary of the map area) into five petrographic units based on colour index and texture. They established five metamorphic zones (four of them to the west, outside of the map area) and recorded an increase in metamorphic grade in a northeasterly direction.

Champan Kamilli (1974) studied the mineral compositions and textures in the Northbrook Batholith and recorded changes due to increasing metamorphic grade. Rivers (1976) presented a detailed structural analysis of the Ompah area, which includes a large part of the Ardoch map area. Moore and Thompson (1980) outlined the complete stratigraphy and structure of the Flinton Group and presented a model for the evolution of this assemblage of units.

MINERAL EXPLORATION

Mineral exploration concentrating on gold dates back to the late 1800s (De Kalb 1900). This early activity led to the discovery of a gold deposit and subsequent mine development. The mine was owned by Boerth Mining Company of Ontario (Property 2) and was in operation until 1904 (Armstrong 1976). Other exploration in this early period led to small surface developments of gold, arsenopyrite, and galena. Shallow shafts on arsenopyrite-bearing quartz veins were sunk at the Cook (5) (Wells 1902) and Webber (13) properties (Ells 1904). The James Mine (12), reputed to carry gold, was worked briefly on Lot 32, Concession IV, Clarendon Township (Smith 1956; Armstrong 1976). Mineral exploration was revived in the area in the early 1950s. Three diamond-drill holes were sunk in the area immediately adjacent to the Boerth Mine. Analyzed narrow core sections revealed gold values of $5.25 to $40/ton (1952) (Assessment Files Research Office, Ontario Geological Survey, Toronto). In 1963, six diamond-drill holes were drilled by Ganda Silver Mines Limited on the arsenopyrite and gold-bearing quartz veins on the Webber property, but only traces of gold were indicated in the filed report (Assessment Files Research Office, Ontario Geological Survey, Toronto). Diamond drilling conducted in 1953 in the vicinity of the galena showing south of Swaugers Lake by Stratmat Limited, and in 1964 by Ganda Silver Mines Limited (7), failed to intercept any mineralization (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The Geochemical Reconnaissance Program of the Geological Survey of Canada (1977) revealed anomalies of Zn, Cu, As, Mo, and Hg on the site of the property presently owned by Selco Mining Corporation Limited (12) in the area between James Lake and Little Green Lake. In 1977, St. Joseph Explorations Limited carried out a program of geological mapping and soil sampling in this area. Weak to moderate anomalies of Cu, Pb, Zn and the presence of chalcopyrite, gold-bearing quartz veins was reported (Assessment Files Research Office, Ontario

Geological Survey, Toronto). Two marble quarries located along the north side of Highway 506 about 4 km east of Plevna operated in the 1960s (Armstrong 1976).

Since 1955, extensive exploration concentrating on uranium has been carried out in the areas of Cross Lake and Pine Lake. Large parcels of land were staked and many properties of 15 to 60 claims underwent complex exploration programs and frequent ownership changes. Reconnaissance, ground, or airborne radiometric and magnetic surveys, trenching, and sampling were carried out on all of the properties. Diamond drilling programs were also conducted on all of the properties, with the exception of the Canadian Arrow Mines property (deposit) (3). One hundred and eleven (111) diamond drillholes totalling 16 334 feet were drilled, some of them outside the eastern limits of the map area, and a large number of analyses were obtained (Assessment Files Research Office, Ontario Geological Survey, Toronto). The extent and results of the exploration activities in the Ardoch Area are detailed under the section "Description of Properties and Occurrences".

PHYSIOGRAPHY

The elevations above sea level in the map area range from about 250 to 400 m. A distinct difference in topography exists on either side of the Plevna Fault, which has a topographic relief of about 40 m. Local relief on the western side of the Plevna Fault is generally low, (<30 m) whereas on the eastern, elevated side of the fault, terrain is more rugged with higher local relief.

A network of streams and valleys shows strong control by the northeast-striking structural trends and northwest-striking joints. Buckshot Creek shows a remarkable zig-zag pattern along the strike of the joints and foliations before it discharges into Mud Lake, and even the lakes have elongated, predominantly strike controlled shapes.

Streams and lakes drain into Cross Lake and form a part of the drainage system of the Mississippi River which flows into the Ottawa River. Distribution of the rock outcrop in the area varies with lithology. The plutonic bodies, and mainly the Northbrook Batholith, provide excellent bedrock exposures, whereas the metavolcanics are poorly exposed in swampy depressions.

Areas underlain by "pure" marbles are topographically flat, with poorly exposed outcrop areas in farm fields, or covered by swampy overburden. In contrast, exposures of marble with lenses and interbeds of quartzite outcrop in the northeast-trending ridges, which alternate with the swampy depressions underlain by pure marbles. Flinton Group metapelite and metaconglomerate display some excellent exposures.

Many major structural features have topographic expressions and are readily recognized on the air photographs. Excellent exposures are present on the shores of Cross Lake and in the road-cuts on Ardoch Road and part of Highway 506, which provide a northwesterly section through most of the map area.

General Geology

The Ardoch Area lies within the Central Metasedimentary Belt as defined by Wynne-Edwards (1972). Its segment IVb (Hastings Basin), containing a succession of metavolcanic and metasedimentary rocks of Late Precambrian (Proterozoic) age (Grenville Supergroup equivalents), forms the most prominent bedrock in the map area.

The Grenville Supergroup is represented by the older metavolcanic and metasedimentary rocks which are correlated with the Hermon and Mayo Groups, as distinguished by Lumbers (1967), and by the younger Flinton Group metasedimentary rocks (Moore and Thompson 1972) that rest unconformably on the older supracrustal rocks in two narrow northeasterly trending structures in the central and southeastern parts of the map area.

Late Precambrian (Proterozoic) felsic plutonic bodies intruded the supracrustal rocks in the northwestern (Abinger Pluton) and the southeastern (Northbrook Batholith) parts of the map area. A small gabbro-diorite stock of Late Precambrian age has intruded the metasedimentary rocks south of the village of Plevna.

The oldest sequence in the area is considered to be the succession of mafic to intermediate, and intermediate to felsic metavolcanic rocks (*see* Table 1) forming four narrow northeast trending belts between Ardoch Lake and the southeastern corner of the map area.

Minor amounts of carbonate and clastic metasedimentary rocks are intercalated within the above units. These metavolcanic rocks are correlated with the Tudor Formation of the Hermon Group (Lumbers 1967; Moore and Sethuraman 1973).

The area east of Ardoch is underlain by fine grained quartzo-feldspathic gneiss, bearing large fragments that may be of volcanic origin (Sethuraman and Moore 1973). This predominantly felsic metavolcanic unit is completely enclosed by marble.

Northwards, the metavolcanic rocks give way to carbonate metasedimentary rocks which are highly intercalated with layers of mafic to ultramafic composition (amphibolites and radiating aggregates of amphiboles) considered to be of tuffaceous origin. South of the village of Ardoch, tuffaceous layers, succeeded by limy mudstone layers, predominate over the marble layers and were outlined as a separate unit in this survey.

Carbonate and clastic siliceous metasedimentary rocks in the map area may be correlative with the upper Hermon Group to lower Mayo Group, which underlie the central and the northwestern parts of the area. Sporadic volcanic activity in the northwestern part of the map area is demonstrated by the presence of mafic gneisses and quartz-potassium feldspar rich gneisses, which are believed to be of volcanic origin.

The metavolcanic rocks in the northwestern part of the map area show a higher degree of deformation and reconstitution, their primary textures having been completely obliterated compared to the metavolcanic rocks in the southeastern part of the map area, which display some original structural and textural characteristics. There is no evidence to suggest that the metavolcanic rocks in the northwestern part of the map area are the same or similar to the metavolcanic rocks in the southeastern part of the map area.

The Northbrook Batholith, comprising rocks of trondhjemitic to granodioritic compositions, has intruded the Hermon Group metavolcanics in the Cross Lake area; and a small part of the granitic Abinger Pluton extends into the northwestern part of the map area.

All intrusive bodies, including small mafic intrusions, are considered to be syntectonic to late tectonic, having been emplaced in the order: (1) Sodic intrusions (Northbrook Batholith). (2) Gabbro-diorite intrusions (gabbro-diorite stock south of the village of Plevna). (3) Granitic intrusions (Abinger granitic pluton) (Lumbers 1967). Middle and late tectonic pegmatite dikes and sills are widespread within and in the border zones of the felsic plutonic bodies.

The youngest metasedimentary rocks in the map area belong to the Flinton Group and rest unconformably on the older metasediments of the Grenville Supergroup in the narrow northeasterly striking Fernleigh and Ompah Synclines (Moore and Thompson 1972), and in the synformal-antiformal structure in the southeastern corner of the map area. The Fernleigh Syncline extends into the map area from the village of Bishop Corners (some 14 km beyond the western boundary of the map area), crosses the map area diagonally, and extends to the northeast, beyond the northeastern limits of the map area. Within the map area, three of the six formations of the Flinton Group distinguished by Moore and Thompson (1980) are present in the Fernleigh Syncline: the Bishop Corners Formation, the Myer Cave Formation, and the Fernleigh Formation.

The Bishop Corners Formation is represented by a continuous horizon of aluminous metasedimentary schist on the northern limb of the syncline and by the polymictic conglomerate, which appears on the southern limb of the syncline, in the northeastern part of the map area.

The Myer Cave Formation comprises carbonate metaconglomerate, graphitic-pyritic schist, and marble. The carbonate metaconglomerate exposed on the southern limb of the Fernleigh Syncline changes laterally into polymictic conglomerate of the Bishop Corners Formation 3 km northeast of the village of Ardoch (Moore and Thompson 1972, 1980).

The Ompah Syncline rock suite comprises calcareous quartzite, quartzite-pebble conglomerate, polymictic conglomerate, and biotite-hornblende schist, all of the Bishop Corners Formation. In the southeastern corner of the map area, the only Bishop Corners lithology is conglomerate.

Two types of conglomerate are present in the map area. The first type is intraformational in the Hermon and Mayo Groups. This type of conglomerate contains clasts which are poorly sorted and weakly rounded. The conglomerate forms discontinuous layers and lenses representing deposits formed in local topographic lows. The second type of conglomerate is younger, associated with the Flinton Group metasediments. It consists of better sorted and originally more rounded material and forms thicker layers of continuous character suggesting the rejuvenation of the source area on a regional scale.

All of the rocks within the map area have undergone regional metamorphism during the Late Precambrian (Proterozoic). The mineral assemblages in the pelitic schists of the Bishop Corners Formation, and their progressive changes, indicate that the metamorphic grade increases from the lower almandine-amphibolite facies in the southwestern part of the map area, to the middle and middle-upper almandine-amphibolite facies in the northeastern part of the map area.

Structurally, the map area has been subjected to at least two episodes of post-Flinton deformation, and the rocks are folded into a series of northeast trending synforms and antiforms. The first phase of the post-Flinton deformation produced isoclinal folds with northeast striking axial plane foliations. The narrow folds attributed to this phase of deformation occupy a northeast trending belt in the central part of the map area and include the Ompah and the Fernleigh Synclines. Subsequent refolding resulted in more open northeast trending structures in the northwestern (Plevna Synform and Antiform) and the southeastern (Cross Lake Antiform and associated synformal-antiformal structure) parts of the map area. Plutonic bodies were subjected to the same type of deformation.

PROTEROZOIC (LATE PRECAMBRIAN)

METAVOLCANICS

The metavolcanics occur in four northeasterly striking belts between the village of Ardoch and the southeastern corner of the map area. In the Cross Lake area, the metavolcanics were extensively intruded by the plutonic mass of the Northbrook Batholith and they are present as 200 to 1500 m wide zones within and along the northern border of the Northbrook Batholith. Larger and more continuous exposures

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR ARDOCH AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

PLEISTOCENE AND RECENT
Till, gravel, sand; organic deposits, alluvium.

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN (PROTEROZOIC)

MIDDLE TO LATE TECTONIC FELSIC INTRUSIVE ROCKS
Pegmatite dikes, pegmatite sills.

Intrusive Contact

GRENVILLE SUPERGROUP

FLINTON GROUP

FERNLEIGH FORMATION
Biotite-carbonate schist

MYER CAVE FORMATION
Graphite ± pyrite schist; marble, dolomitic marble and interlayered graphite ± pyrite schist and pelitic schist; carbonate clast metaconglomerate, marble.

BISHOP CORNERS FORMATION
Pelitic schists: muscovite-quartz ± biotite ± plagioclase ± garnet ± staurolite ± kyanite ± sillimanite ± magnetite schist; calcareous quartzite, impure calcitic marble; quartzite pebble metaconglomerate, polymictic metaconglomerate, migmatized metaconglomerate; hornblende-biotite-plagioclase ± carbonate schist.

Unconformity

METAMORPHOSED FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

ABINGER PLUTON
Muscovite ± biotite granite gneiss; fine grained leucocratic dikes.

NORTHBROOK BATHOLITH
Trondhjemite gneiss, granodiorite gneiss; feldspar porphyry dikes and sills; coarse grained migmatite with potash feldspar-quartz segregations.

METAMORPHOSED MAFIC INTRUSIVE ROCKS
Medium and coarse grained gabbro and diorite, fine grained, foliated biotite-bearing gabbro-diorite phases, granodiorite and aplite phases, mafic sills and dikes.

Intrusive Contact

METASEDIMENTS

CLASTIC METASEDIMENTS

Calcareous sandstone: muscovite-biotite-carbonate-plagioclase-quartz gneiss and schist; lithic sandstone, lithic calcareous sandstone, lithic mudstone; siliceous siltstone: pyrite-muscovite-quartz-plagioclase gneiss and schist.

CARBONATE METASEDIMENTS

Grey and white, mostly massive, dolomitic marble, locally grey, silty dolomitic marble, grey and white laminated marble, massive grey and white marble; marble and dolomitic marble with large lenses and layers of white quartzite, locally up to 30%; marble interlayered with clastic siliceous metasediments: rusty weathering muscovite-pyrite-quartz-plagioclase gneiss and schist, biotite-quartzo-feldspathic gneiss; marble interlayered with hornblende-biotite-plagioclase ± carbonate gneiss; tremolite, phlogopite, diopside, scapolite-bearing marble; marble interlayered with layers of radiating aggregates of amphibole or amphibolite; marble metaconglomerate; tremolite, phlogopite-bearing fragmental marble.

FELSIC TO MAFIC GNEISSES OF MIXED VOLCANIC AND SEDIMENTARY ORIGIN

INTERLAYERED FELSIC AND INTERMEDIATE GNEISSES

Biotite-quartzo-feldspathic ± muscovite ± garnet gneiss; laminated biotite-quartzo-feldspathic ± garnet gneiss; biotite-plagioclase-quartz ± carbonate ± microcline ± muscovite gneiss, locally coarse grained segregations of hornblende or biotite, local garnet porphyroblasts; hornblende-biotite-quartz-plagioclase gneiss; biotite-hornblende-quartz-plagioclase gneiss.

MAFIC GNEISSES

Hornblende-plagioclase ± biotite ± garnet gneiss, biotite-hornblende-plagioclase-quartz schist; scapolite-diopside-hornblende-carbonate-plagioclase ± garnet gneiss; coarse grained amphibolite; fine grained amphibolite with relict amygdules.

METAVOLCANICS

MAFIC TUFFS INTERLAYERED WITH CARBONATE METASEDIMENTS AND LIMY MUDSTONES

Biotite-carbonate ± garnet schist; hornblende-carbonate ± biotite ± garnet schist; layers of radiating aggregates of amphibole: hornblende-anthophyllite-plagioclase ± spinel ± biotite ± garnet assemblage, cummingtonite-tremolite-magnesium chlorite ± olivine assemblage; amphibolites: cummingtonite-anthophyllite-plagioclase ± magnesium chlorite assemblage, hornblende-plagioclase ± carbonate assemblage.

FELSIC TO INTERMEDIATE METAVOLCANICS

Fragmental muscovite-biotite-potassium feldspar-plagioclase-quartz gneiss; hornblende-biotite-quartz-plagioclase gneiss, locally with relict fragments; biotite-plagioclase-quartz ± hornblende ± muscovite gneiss, local garnet porphyroblasts; garnet-muscovite-biotite schist.

MAFIC TO INTERMEDIATE METAVOLCANICS

Hornblende-plagioclase ± garnet gneiss, local hornblende porphyroblasts, local relict phenocrysts of plagioclase, local diopside-hornblende-plagioclase gneiss; massive amphibolite, pillowed amphibolite; quartz-biotite-hornblende-plagioclase ± garnet gneiss, local relict phenocrysts of plagioclase; fragmental hornblende-plagioclase ± biotite ± carbonate gneiss.

of the same sequence of metavolcanics are present southwest of the map area, where their continuity is not disrupted by the intrusion of the Northbrook Batholith.

All metavolcanics were metamorphosed within the range of the almandine-amphibolite facies and their primary structural and textural features are largely destroyed. Metamorphic grade to the southwest of the map area is considerably lower and structural and textural characteristics of the metavolcanic rocks are better preserved (Moore and Morton 1980).

None of the narrow belts or wider zones within these belts of metavolcanic rocks are compositionally uniform and therefore the metavolcanics are classed as mafic to intermediate and felsic to intermediate. From south to north, the metavolcanic rocks are progressively more felsic.

In outcrop, the metavolcanic units are distinguished by colour index, which is 40 to 50% in the mafic metavolcanics, 20 to 40% in the intermediate metavolcanics, and about 10 to 20% in the felsic metavolcanic rocks. The fine grained and massive varieties of metavolcanics generally have a darker colour and the colour index may not be a reliable guide for field identification of these rocks.

Sethuraman and Moore (1973) classified the suite of metavolcanic rocks occurring between Bishop Corners and Donaldson, which includes the metavolcanics within the map area, as calc-alkalic. Individual members of the suite showed chemical affinities to olivine tholeiites, alkaline basalts, high-alumina basalts, basaltic andesites, andesites, and rhyodacites. They concluded that this suite represents a single cycle of volcanism.

Mafic to Intermediate Metavolcanics

Mafic to intermediate metavolcanics (unit 1) are present in the two northeast trending belts in the southeastern corner of the map area. Intrusion of the Northbrook Batholith separates these two main belts, comprising rocks of basaltic and andesitic compositions. A few discontinuous, 50 to 80 m wide bands of metavolcanic rocks occur within the Northbrook Batholith.

At the contacts of the metavolcanics with the Northbrook Batholith, large xenoliths of metavolcanics are present in the plutonic rocks, and concordant layers of fine grained plutonic rocks are present within the metavolcanics. In these contact zones, the plutonic rocks show a decrease in grain size, whereas the metavolcanics show an increase in grain size. Concordant sheets of pegmatite intrude the metavolcanics in many places, and north of Kings Lake the volume of pegmatite is greater than that of the metavolcanics. Highly deformed structures resembling pillows were observed west of the village of Covale and east of Little Black Bay.

The colour of the mafic to intermediate metavolcanics varies from dark green to dark grey-green depending on the mineralogy and the texture of the rocks. Massive, fine grained amphibolites display a generally darker colour, whereas foliated varieties containing segregated layers and lenses of mafic and felsic compositions show an overall lighter colour. The grain size varies from 0.30 to 1.0 mm and occasionally coarse grained varieties with a grain size up to 5 mm are encountered.

The metavolcanics display a foliated, schistose to gneissic fabric and less commonly a non-oriented fabric. Foliation is defined by the alignment of the prismatic grains of hornblende and by the segregation of subparallel layers of mafic and felsic phases.

The mafic metavolcanics are represented by hornblende-plagioclase gneisses and schists (unit 1a) and amphibolites (unit 1b). As seen in thin section, the gneisses consist of subidioblastic grains of hornblende and plagioclase. Plagioclase is untwinned or poorly twinned with pericline twinning. Compositions of plagioclase vary from An_{40} to An_{55} and the proportion of plagioclase to hornblende is about 50:50. Common accessory minerals are magnetite, biotite, apatite, and sphene. Magnetite roddings are usually well aligned. White mica and/or carbonate occur as alteration products of plagioclase; and epidote, biotite, chlorite, and carbonate may be a replacement of hornblende in places. Some species contain

up to 3% sulphide mineralization (pyrite, pyrrhotite). Some of these rocks are porphyroblastic containing large aligned grains of hornblende, garnet, and large aggregates of plagioclase which might have been formed by the recrystallization of original plagioclase phenocrysts. In general, all the hornblende-plagioclase gneisses, schists, and amphibolites display homeoblastic fabrics with straight to slightly curved low energy grain boundaries, indicative of equilibrium conditions.

Intermediate metavolcanics (unit 1c) are represented by the quartz-biotite-hornblende gneisses, schists, and amphibolites. Compositionally, they differ from the mafic metavolcanics by the presence of ubiquitous biotite and 5 to 8% free silica. Quartz and plagioclase grains tend to segregate into subparallel layers, or may be set in a mosaic together with hornblende and biotite in the rock types with poorly oriented to non-oriented mineral assemblages. One of the microscopically examined specimens contained a large amount of sphene, indicative of a more alkaline parental rock.

Relict phenocrysts of plagioclase, showing replacement by small recrystallized grains of plagioclase, are rarely seen in thin section. A thin sectioned sample collected from a metavolcanic unit north of Kings Lake contained plagioclase, diopside, epidote, scapolite, tourmaline, and microline, thus showing on one hand the progression in the metamorphic grade, and on the other hand the enrichment in alkalies due to the chemical effects of the neighbouring pegmatites. The presence of originally massive rocks, layered rocks, and porphyritic rocks suggests that massive flows, porphyritic flows, and tuffaceous equivalents were originally present.

A narrow horizon containing up to 12 cm long, lighter coloured patches, and patches of epidote, is considered to represent an original fragmental or brecciated phase (unit 1d). Some narrow horizons, e.g. porphyritic horizons and fragmental horizons, are remarkably persistent along strike.

The mafic metavolcanics are the predominant rock type in the most southern belt of metavolcanic rocks. In this area, the metavolcanic rocks are cut by many large, concordant sheets of pegmatite, which in some parts predominate in volume over the metavolcanic units. These intrusions affected and modified the mineralogy and texture of the metavolcanics in the contact areas. A large (400 by 1600 m) concordant body of migmatitic character (unit 9c) is infolded by the metavolcanic rocks in the area east of the Little Black Bay. These intrusions affected and modified the mineralogy and texture of the metavolcanic rocks in the contact areas.

The belt of metavolcanics that extends from the village of Coxvale to the Kings Lake narrows in a northeasterly direction and north of Kings Lake is only about 200 m wide. Intermediate metavolcanics are the most abundant rock type within this belt. Intercalated mafic metavolcanic rocks occur in southern (basal) parts of this unit, and felsic metavolcanic rocks (unit 2c) are, in a few places, intercalated with intermediate metavolcanics in the northern (upper) parts of this unit.

Felsic to Intermediate Metavolcanics

Felsic to intermediate metavolcanics are confined to two northeasterly striking belts along the northern border area of the Northbrook Batholith. The narrow (200 m wide) more southern belt is continuous along strike across the whole map area, whereas the wider, northern belt is abruptly terminated at Ardoch Lake. A 10 to 80 m wide layer of marble separates the two belts of felsic to intermediate metavolcanics.

In the narrow southern belt, the most abundant rock type is fine to medium grained, light grey biotite-quartz-plagioclase gneiss consisting of 80 to 85% felsic minerals and 15 to 20% mafic minerals. Felsic phases are represented by oligoclase, quartz, and small amounts of orthoclase. Minor amounts of hornblende or muscovite accompany biotite in some of these rocks. Common accessory minerals are subparallel rods of magnetite, and locally, garnet porphyroblasts confined to the biotite-rich layers. Foliation is defined by a planar to planar-linear alignment of biotite and/or segregation bands of alternating feldspathic and quartz-

rich phases. Very fine grained massive phases are not common. Quartz-biotite-hornblende-plagioclase gneiss, corresponding to intermediate metavolcanics, and a narrow layer of pelitic schist (garnet-muscovite-biotite schist) are intercalated within this predominantly felsic unit.

Felsic metavolcanic rocks, comprising rocks of dacitic and rhyodactic composition, are present in the northeasterly striking belt east of Ardoch Lake. This unit is completely enclosed by marble and white clastic siliceous metasedimentary rocks. Narrow layers of clastic siliceous metasediments, marble, and amphibolite are intercalated within this unit. Marble fragments and carbonate-rich phases are present within the unit at the contacts. The rocks are light grey, generally fine grained, poorly foliated, and contain pink, mostly elongate patches which are thought to be relicts of large fragments. Fragments are concentrated mainly in the northern part of this unit. Due to the irregular and inconsistent distribution of the fragments, the fragmental nature of these rocks may be difficult to recognize in outcrop.

The felsic and felsic fragmental rocks consist of fine grained quartz, oligoclase, microcline, biotite, and muscovite. Foliation is defined by the parallel alignment of the biotite and muscovite flakes. Fragments consist of coarser crystalline aggregates of microcline, minor muscovite, and quartz: or large strained grains of quartz and non-oriented grains and clusters of muscovite. Accessory minerals are magnetite and apatite.

A potassium feldspar-poor, plagioclase-rich variety corresponding to dacitic composition (unit 2b) is present in some locations, mainly in the more southern parts of this belt. Hornblende instead of muscovite accompanies the biotite. These rocks are medium grained, well foliated, and contain subparallel segregated layers of hornblende, or thick (up to 6 cm) often boudinaged bands of hornblende. Porphyroblasts of almandine occur locally in discontinuous layers within this unit.

Mafic Tuffs Interlayered with Carbonate Metasediments and Limy Mudstones

Rocks of unit 3 form a northeast trending, elongated, concordant, lens shaped body along the southern limb of the Fernleigh Syncline. This unit is completely enclosed by marble and smaller lenses of these rocks are present within the adjacent marble unit. This unit consist of layers of mafic to ultramafic composition, layers of marble, and pelitic-calc-silicate layers. Intercalations of the individual members of this unit occur on a scale of 10 cm to several metres. Marble is less abundant than other lithologies within unit 3. The mafic units 3c and 3d are confined mainly to the southern part of this belt, although narrow layers of unit 3c are also intercalated within the pelitic-calc-silicate schist, unit 3a, in the northern part of this belt. A non-oriented fabric within individual mafic and ultramafic layers strongly contrasts with the macroscopic-scale layering and stratification (Photo 1) of this whole unit.

Map unit 3a comprises dark grey to brown, fine grained, well foliated to schistose rocks, which in field classification were designated as biotite-carbonate schists. Microscopic examination reveals a large number of mineral phases, reflecting the complex bulk composition and also the relatively high metamorphic grade of these rocks. Foliation is defined by the alternating bands of different composition and/or grain size (0.02 to 0.3 mm). Individual bands consist of biotite, plagioclase-quartz-biotite, and carbonate-scapolite-quartz. Calc-silicate segregations are generally coarser grained and also contain porphyroblasts of diopside and hornblende. Microcline and myrmekite are present in the feldspathic bands. Small relict grains of staurolite, and large poikiloblasts of garnet are confined to the biotite-rich bands. Common accessory minerals are sphene, apatite, tourmaline, leucoxenized ilmenite, and magnetite.

Unit 3b is a dark green, well foliated, medium to coarse grained hornblende-carbonate schist, bearing the assemblage hornblende-carbonate-diopside-scapolite-oligoclase-quartz±biotite±garnet. Units 3a and 3b are usually found in contact with each other, only being separated by alternating microscopic bands of pelitic and calc-silicate composition, suggesting that these bands represent the original layering of these rocks.

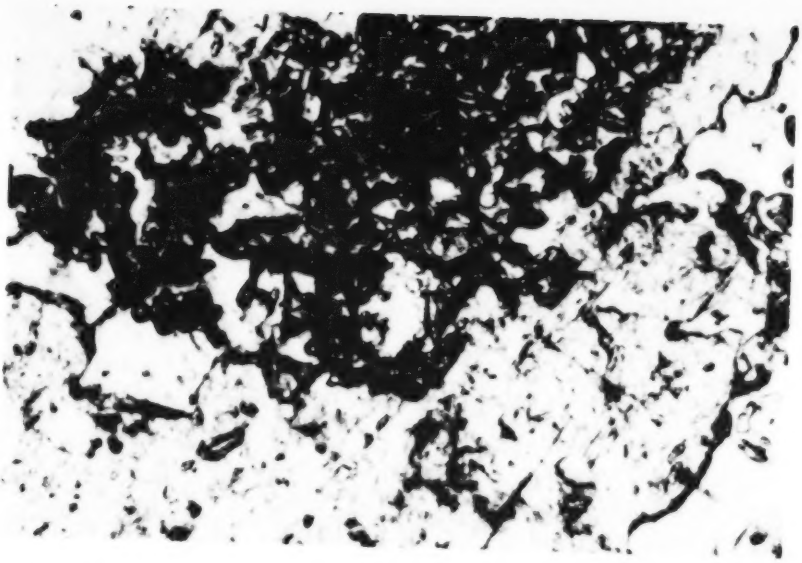

Photo 1. *Alternating layers of marble and radiating aggregates of amphibole, map unit 3.*

Rock unit 3c, comprising rocks of mafic to ultramafic compositions, is usually found intercalated with narrow layers of marble. This characteristic is well observed in roadcuts, whereas in many small field outcrops the marble is often weathered out and only resistant mafic ridges are observed. The interlayered marble is medium grained, crystalline, rusty weathering, and strongly calcitic in composition. Thickness of the individual mafic to ultramafic layers may vary from 10 cm to 10 m. These layers are highly deformed and often boudinaged due to the contrasting competency of the adjacent lithologies.

Dark green to black rocks composed of medium to coarse grained radiating aggregates of amphibole, and showing no presence of felsic phases in hand sample, are included in this unit. Two similar looking thin sectioned samples, differing only in grain size, revealed the following mineral assemblages: (1) hornblende anthophyllite-plagioclase-spinel-biotite±garnet; and (2) cummingtonite-tremolite-magnesium-chlorite-olivine.

The coarse grained hornblende-anthophyllite-plagioclase-spinel-biotite rock consists of large non-oriented poikiloblasts and sheaf-like aggregates of pale brown hornblende, and grey anthophyllite in a matrix, comprising about 15% of the rock, of very fine grained granoblastic plagioclase and minor flakes of biotite. Small wormy grains of green spinel are included in plagioclase (Photo 2). Anthophyllite often mantles hornblende grains. The presence of spinel indicates the silica deficiency of this rock.

The fine grained rock consisting of the stable assemblage cummingtonite-tremolite-magnesium chlorite-olivine consists of non-oriented, almost fibrous grains and aggregates of tremolite and cummingtonite, flakes and plates of chlorite, and porphyroblasts of olivine. No felsic phases are present in this rock type.

Unit 3d comprises mafic non-foliated to poorly foliated rocks, forming concordant layers and lenses within unit 3c. These rocks are green to greyish green, medium to coarse grained, and often porphyroblastic with the mafic phase forming porphyroblasts. Two major assemblages were distinguished within this unit, broadly

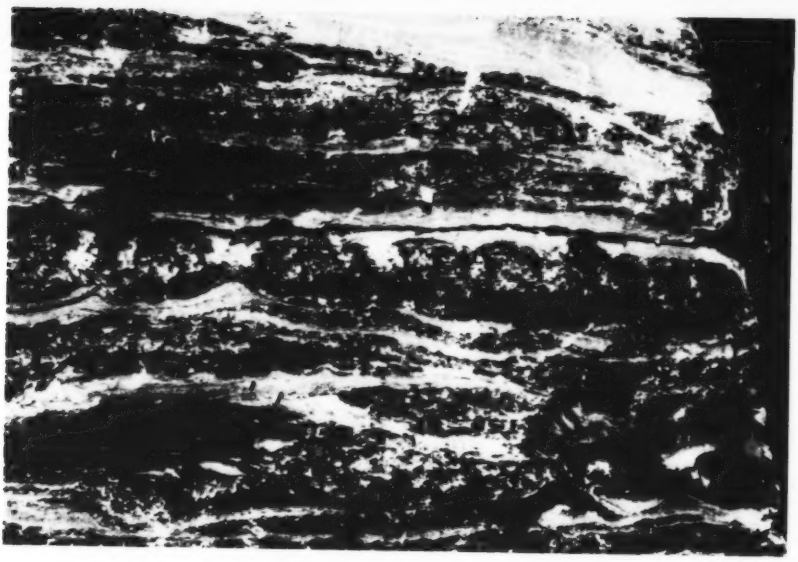

Photo 2. *Photomicrograph of spinel from hornblende-anthophyllite-plagioclase rock, map unit 3c.*

classified as amphibolite: (1) anthophyllite-cummingtonite-plagioclase±magnesium chlorite±carbonate; (2) hornblende-plagioclase±magnesium chlorite±carbonate.

The amount of carbonate in these rocks is related to the proximity of their contact with the marble layers. These rocks have mostly a non-oriented fabric and the amphiboles invariably form large (2 to 5 mm) single porphyroblasts or sheaf-like aggregates set in a fine grained granoblastic matrix of plagioclase, or plagioclase and calcite (Photo 3). Proportion of the mafic and felsic phases varies considerably and plagioclase may constitute anywhere from 20 to 60% of the rock. Marble lenses intercalated within this unit display a range of compositions from pure calcitic marble, to phlogopite marble, to diopside-scapolite-phlogopite marble.

The author interprets this unit to represent a pile of mafic volcanic ash and debris deposited concurrently with the carbonate sediments and followed by the sedimentation of limy muds. They are considered to have undergone alteration involving leaching and redistribution of elements during diagenesis or a low grade metamorphic event. Subsequently, these rocks were metamorphosed within the high rank regional metamorphism to yield their present mineral assemblages.

FELSIC TO MAFIC GNEISSES OF MIXED VOLCANIC AND SEDIMENTARY ORIGIN

A series of mafic, intermediate, and felsic gneisses and schists, believed to have originated from sedimentary and volcanic antecendents, outcrop in synforms and antiforms in the northwestern part of the map area. Variation in the rock composition often occurs on a small (1 m) scale. This compositional variation may partly be attributed to the intensive isoclinal folding, but also may reflect variation in the composition of the original layers.

Mafic Gneisses

Map unit 4 comprises gneisses of mafic composition consisting essentially of plagioclase and hornblende. They are dark green to grey-green in colour, medium to fine grained, and generally well foliated. The gneisses, believed to be of

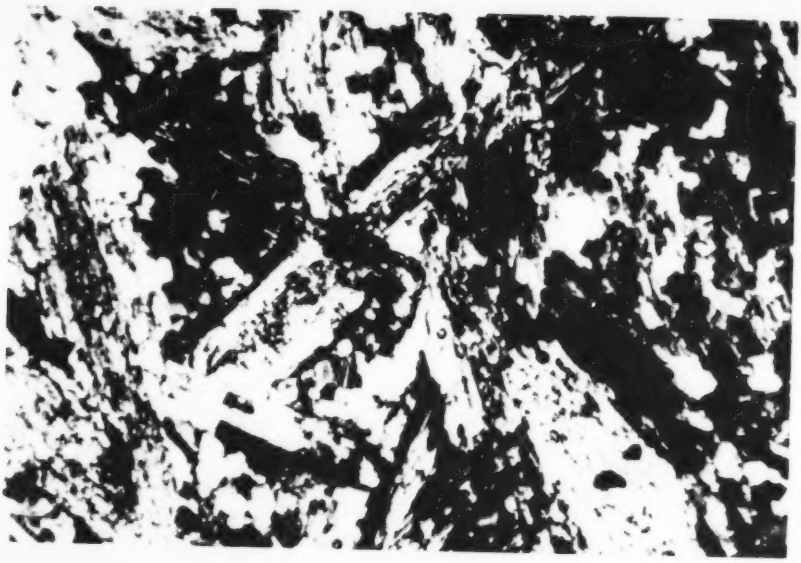

Photo 3. *Photomicrograph of radiating aggregates of anthophyllite and cummingtonite, map unit 3d.*

volcanic origin, are fine to medium grained and carry about 50% subidioblastic, more or less equant grains of hornblende, and granoblastic, well rounded grains of plagioclase. Magnetite and biotite are minor phases and garnet poikiloblasts occur in some of the rocks. The subparallel orientation of the long axes of hornblende crystals defines the foliation.

Calc-silicate gneisses believed to be of sedimentary origin, although similar in composition, usually display more fabric and compositional heterogeneity. Compositional layering occurs on the macroscopic and microscopic scale. These gneisses consist of coarse and fine grained bands of plagioclase, hornblende, biotite, and variable amounts of quartz. Additional phases include carbonate and muscovite. Syntectonic poikiloblasts of garnet, strongly strained quartz, and mortar textures were locally encountered. Another common assemblage is plagioclase-quartz-carbonate-scapolite-hornblende-diopside and coarse grained biotite-hornblende-plagioclase-quartz schist. Although the rocks reveal contrasting textures and also compositional differences on a microscopic scale, macroscopically they are very similar and no attempt has been made to further subdivide them.

Coarse grained poorly oriented hornblende-plagioclase-amphibolite, that may be of intrusive origin, forms only a small proportion of this unit. Rocks of this character were encountered west of Cards Lake and within the carbonate and metaclastic units (6, 7b) in the north central to northeastern part of the map area.

Unit 4b forms a narrow band within the marble in the hinge region of the Plevna Antiform. It is a fine grained, dark green to black rock, spotted with green, oval-like patches resembling amygdules. A thin sectioned sample revealed a very fine granoblastic matrix of plagioclase, quartz, biotite, and hornblende. Coarse aggregates of plagioclase replacing original phenocrysts and small porphyroblasts of magnetite are present. Spots up to 5 mm in diameter are filled with carbonate, scapolite, quartz, and clusters of hornblende. The texture suggests a volcanic origin and the mineralogy corresponds to an andesitic composition.

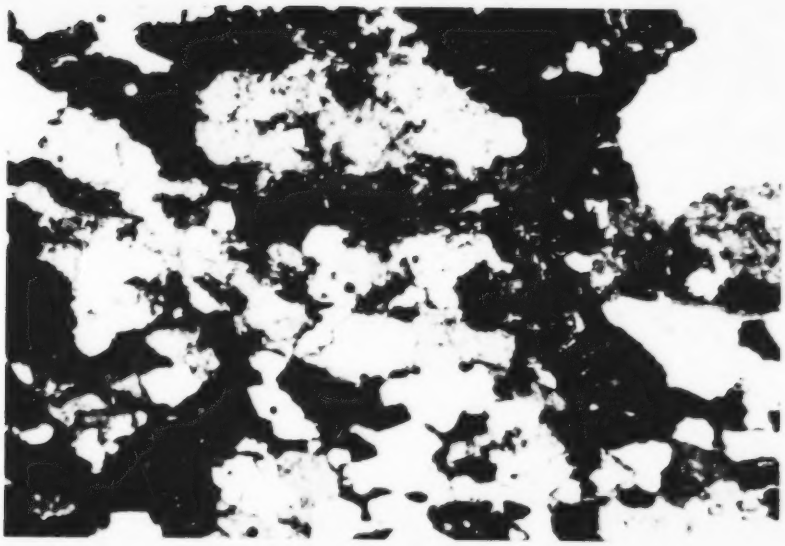

Photo 4. *Photomicrograph of fine grained biotite-quartz band in feldspathic gneiss, map unit 5b.*

Interlayered Felsic Gneisses and Intermediate Gneisses

Map unit 5 comprises pink, grey to dark grey, fine to medium grained quartzo-feldspathic gneisses. The prevailing mafic mineral phase is biotite. Minor muscovite or hornblende may be present. Biotite-rich varieties range in texture from gneiss to schist. Subdivision of this unit has been made on the basis of colour, which reflects the major feldspathic phase present. Unit 5a is a pink, fine to medium grained leucocratic gneiss. Characteristically, larger parts of an outcrop have a massive appearance, yet the rock over a small distance changes to laminated gneiss with streaks and often thin laminae of biotite.

This pink gneiss, along with a poorly foliated fabric, consists of a very fine grained (0.07 mm) granoblastic matrix of quartz and feldspar. Large, sericitized grains of oligoclase and orthoclase (0.5 mm), resembling relic phenocrysts, are replaced along the edges by a fine grained quartzo-feldspathic mosaic. Minor, poorly oriented flakes of biotite define the foliation. Other species may contain microcline and/or muscovite and/or garnet, and display relatively coarser grained segregations of quartz. The fabric is usually fine grained, idioblastic to subidioblastic and homogeneous in grain size. Minor accessories are apatite and magnetite. The lack of stratification in some parts, and the fine lamination in other parts, suggest that it originally consisted of felsic flows interlayered with felsic tuff or clastic siliceous sediments.

Map unit 5b comprises a variety of gneisses, light grey to dark grey in colour, and fine to medium grained. Compositional and textural variation is essentially a function of the amount of biotite and such variation may occur within an outcrop. Typically, at the contact of two lithological units, there is a mutual intercalation on a macroscopic scale. The light grey gneiss (unit 5b) consists of ubiquitous quartz and plagioclase and variable amounts of microcline or carbonate. Textures vary from granoblastic and granoblastic-polygonal to heteroblastic. Subparallel, oriented flakes and laminae of the sheet-silicate minerals and/or segregation bands of different grain size and composition define a foliation (Photo 4). Biotite is ubiquitous and muscovite appears in some of the species.

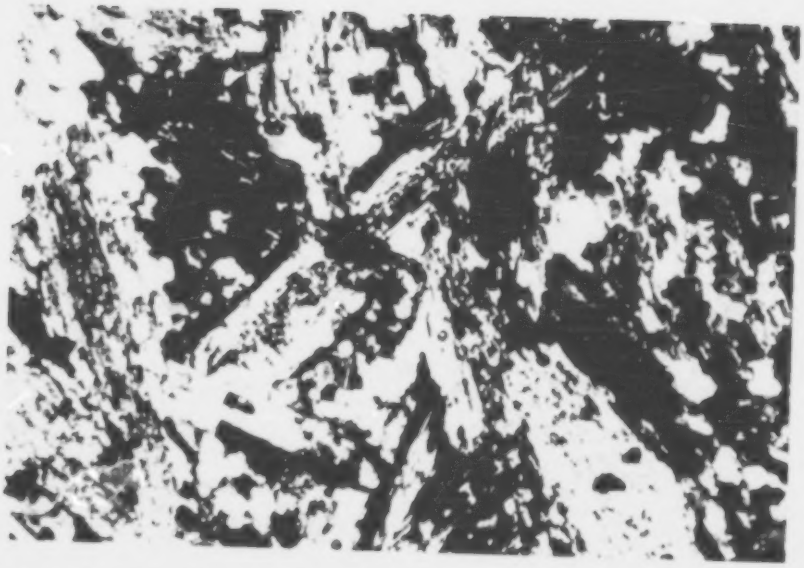

Photo 3. *Photomicrograph of radiating aggregates of anthophyllite and cummingtonite, map unit 3d.*

volcanic origin, are fine to medium grained and carry about 50% subidioblastic, more or less equant grains of hornblende, and granoblastic, well rounded grains of plagioclase. Magnetite and biotite are minor phases and garnet poikiloblasts occur in some of the rocks. The subparallel orientation of the long axes of hornblende crystals defines the foliation.

Calc-silicate gneisses believed to be of sedimentary origin, although similar in composition, usually display more fabric and compositional heterogeneity. Compositional layering occurs on the macroscopic and microscopic scale. These gneisses consist of coarse and fine grained bands of plagioclase, hornblende, biotite, and variable amounts of quartz. Additional phases include carbonate and muscovite. Syntectonic poikiloblasts of garnet, strongly strained quartz, and mortar textures were locally encountered. Another common assemblage is plagioclase-quartz-carbonate-scapolite-hornblende-diopside and coarse grained biotite-hornblende-plagioclase-quartz schist. Although the rocks reveal contrasting textures and also compositional differences on a microscopic scale, macroscopically they are very similar and no attempt has been made to further subdivide them.

Coarse grained poorly oriented hornblende-plagioclase-amphibolite, that may be of intrusive origin, forms only a small proportion of this unit. Rocks of this character were encountered west of Cards Lake and within the carbonate and metaclastic units (6, 7b) in the north central to northeastern part of the map area.

Unit 4b forms a narrow band within the marble in the hinge region of the Plevna Antiform. It is a fine grained, dark green to black rock, spotted with green, oval-like patches resembling amygdules. A thin sectioned sample revealed a very fine granoblastic matrix of plagioclase, quartz, biotite, and hornblende. Coarse aggregates of plagioclase replacing original phenocrysts and small porphyroblasts of magnetite are present. Spots up to 5 mm in diameter are filled with carbonate, scapolite, quartz, and clusters of hornblende. The texture suggests a volcanic origin and the mineralogy corresponds to an andesitic composition.

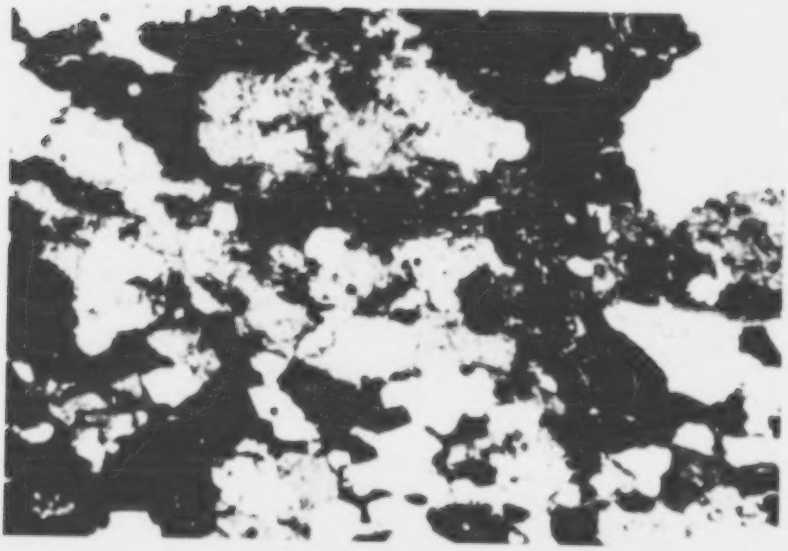

Photo 4. Photomicrograph of fine grained biotite-quartz band in feldspathic gneiss, map unit 5b.

Interlayered Felsic Gneisses and Intermediate Gneisses

Map unit 5 comprises pink, grey to dark grey, fine to medium grained quartzo-feldspathic gneisses. The prevailing mafic mineral phase is biotite. Minor muscovite or hornblende may be present. Biotite-rich varieties range in texture from gneiss to schist. Subdivision of this unit has been made on the basis of colour, which reflects the major feldspathic phase present. Unit 5a is a pink, fine to medium grained leucocratic gneiss. Characteristically, larger parts of an outcrop have a massive appearance, yet the rock over a small distance changes to laminated gneiss with streaks and often thin laminae of biotite.

This pink gneiss, along with a poorly foliated fabric, consists of a very fine grained (0.07 mm) granoblastic matrix of quartz and feldspar. Large, sericitized grains of oligoclase and orthoclase (0.5 mm), resembling relic phenocrysts, are replaced along the edges by a fine grained quartzo-feldspathic mosaic. Minor, poorly oriented flakes of biotite define the foliation. Other species may contain microcline and/or muscovite and/or garnet, and display relatively coarser grained segregations of quartz. The fabric is usually fine grained, idioblastic to subidioblastic and homogeneous in grain size. Minor accessories are apatite and magnetite. The lack of stratification in some parts, and the fine lamination in other parts, suggest that it originally consisted of felsic flows interlayered with felsic tuff or clastic siliceous sediments.

Map unit 5b comprises a variety of gneisses, light grey to dark grey in colour, and fine to medium grained. Compositional and textural variation is essentially a function of the amount of biotite and such variation may occur within an outcrop. Typically, at the contact of two lithological units, there is a mutual intercalation on a macroscopic scale. The light grey gneiss (unit 5b) consists of ubiquitous quartz and plagioclase and variable amounts of microcline or carbonate. Textures vary from granoblastic and granoblastic-polygonal to heteroblastic. Subparallel, oriented flakes and laminae of the sheet-silicate minerals and/or segregation bands of different grain size and composition define a foliation (Photo 4). Biotite is ubiquitous and muscovite appears in some of the species.

Common accessories are tourmaline, magnetite, zircon, apatite, and sericite. Chlorite and carbonate are common alteration products. With increasing amounts of biotite, these rocks become darker coloured and schistose. Large poikiloblasts (0.5 to 1.5 cm) of syntectonic almandine-garnet occur in the biotite-rich layers throughout this unit. Segregations of coarse grained biotite or hornblende, up to 30 cm in width, commonly are interlayered in this unit. Macroscopic and microscopic structural and textural characteristics suggest that these gneisses are of sedimentary origin.

Map unit 5c is a fine to medium grained plagioclase gneiss bearing hornblende as well as biotite. It has well a foliated fabric defined by alternating layers of biotite-plagioclase-quartz and hornblende-plagioclase-quartz. Quartz may constitute about 10 to 30% of the rock. Two thin sectioned samples contained 5% and 10% of magnetite respectively. This unit is often found at the contacts of the mafic and felsic gneisses, or forms narrow layers within unit 5b and generally has limited extent.

Except for map unit 5a, all of the rocks display a strong penetrative foliation. Small isoclinal to recumbent folds and shearing are evident in many outcrops in the area. Microscopic-scale deformation features include mortar structures, snowball garnets, kinked minerals, and shears. Mostly concordant quartz veins, 10 to 50 cm wide and often broken up and boudinaged, form prominent components of map unit 5.

METASEDIMENTS

Carbonate Metasediments

Extensive outcrops of carbonate metasediments (map unit 6) occur in northeast trending zones and large fold structures north of the Northbrook Batholith.

Map units 6a and 6b comprise dolomitic marble and calcitic marble respectively. Both marble and dolomitic marble are usually medium to coarse grained and display granoblastic texture. The rocks vary in colour from white to buff-grey and grey-blue, with pink and green shades being less common. In general, these units are massive, with local dark laminations caused by the segregation of graphite or phlogopite. The mineral fabric is idioblastic to subidioblastic.

Fine grained, grey, silty dolomitic marble is exposed in a few outcrops along and near Highway 509 east of the village of Plevna. Map unit 6c is restricted to the area northwest of the Fernleigh Syncline. It consists of marble or dolomitic marble containing interbeds of white quartzite. Invariably, quartzite layers have been broken up and contorted and form concordant lenses and slabs within the carbonate metasediments. Reaction rims of white elongated tremolite crystals, or crystal aggregates of fibrous tremolite crystals, have been formed at marble-quartzite interfaces. Quartzite locally makes up to 30% of the marble outcrops. Typically, these layers are resistant to weathering and are found in the northeasterly trending ridges, whereas pure marble and dolomitic marble are found in the northeast trending terrain depressions. Large outcrops of this unit are present in the hinge of the Plevna Synform, in the core of the Plevna Synform, and on the limbs of narrow antiforms between Fernleigh and the northeastern corner of the map area. Unbroken, but discontinuous layers of white to buff rusty quartzite are present only in the core of the Plevna Synform, to the west and to the east of the Plevna Fault.

Map units 6d and 6e comprise marble and dolomitic marble with interlayers (5 cm-5 m) of the following rock types: (unit 6d) rusty weathering muscovite-pyrite-quartz-plagioclase gneiss; (unit 6d) biotite-quartzo-feldspathic gneiss; (unit 6e) hornblende-biotite-plagioclase±carbonate gneiss. These narrow interlayers are often contorted and boudinaged due to the different ductilities of the individual layers (Photo 5).

Map unit 6f comprises marble and dolomitic marble containing calc-silicate mineral assemblages. Tremolite and phlogopite are dominant phases, diopside and scapolite may be additional phases. Calc-silicate minerals either are segregated

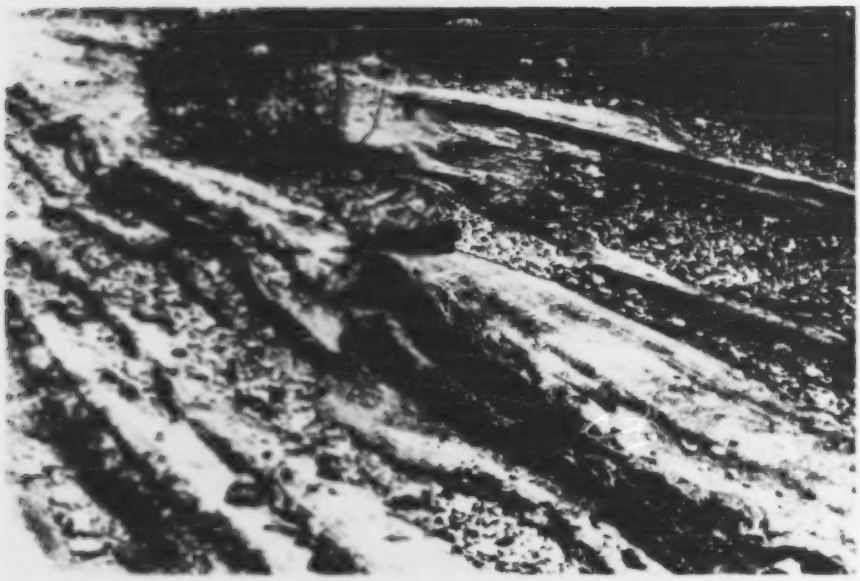

Photo 5. Boudinaged layers of quartzite in marble, map unit 6d.

into subparallel layers to yield banded marble, or occur as lenses and accumulations of large non-oriented grains.

Map unit 6g is limited to the area southeast of the Fernleigh Syncline and is bounded by the western shore of Kashwakamak Lake in the western part of the map area, and pinches out west of Ardoch Lake in the eastern part of the map area.

It consists of calcitic marble interlayered with the layers of radiating aggregates of amphibole (unit 3c) and amphibolite, which is similar to the amphibolite of unit 3d, but generally contains a smaller proportion of mafic minerals (20 to 30%). The amphibolite has a non-oriented fabric. Long disoriented grains of hornblende set in a white matrix of plagioclase and carbonate give the rock a "diabasic texture". Microscopic examination reveals large (3 to 5 mm) elongated porphyroblasts of hornblende set in a fine grained granoblastic to granoblastic-polygonal matrix of plagioclase and carbonate.

Marble metaconglomerate and fragmental marble (unit 6h) were encountered in three locations. Three bands of metaconglomerates are exposed along Highway 506, just north and south of the Swamp Creek crossing. The layers are discontinuous along strike and do not extend east of the Plevna Fault. On the western side of the road, exposures are poor because of swampy overburden adjacent to Swamp Creek, and the real extent of the conglomerate in this area is not known. The widest of the conglomerate layers is the middle one, just north of Swamp Creek; being about 120 m wide and traceable for 3 km along strike. The middle band is separated from the northern one by a layer of quartzo-feldspathic biotite gneiss (units 5a, 5b) and from the southern one by a marble layer (unit 6).

The marble metaconglomerate consists of flattened and stretched marble clasts averaging 2 to 25 cm in diameter (Photo 6), set in a matrix of medium grained, white to grey, banded phlogopite-graphite marble. A rim of phlogopite flakes is often developed at the matrix-clast interface. Thin concordant layers and streaks of coarse, crystalline, pink calcite are characteristic of this unit.

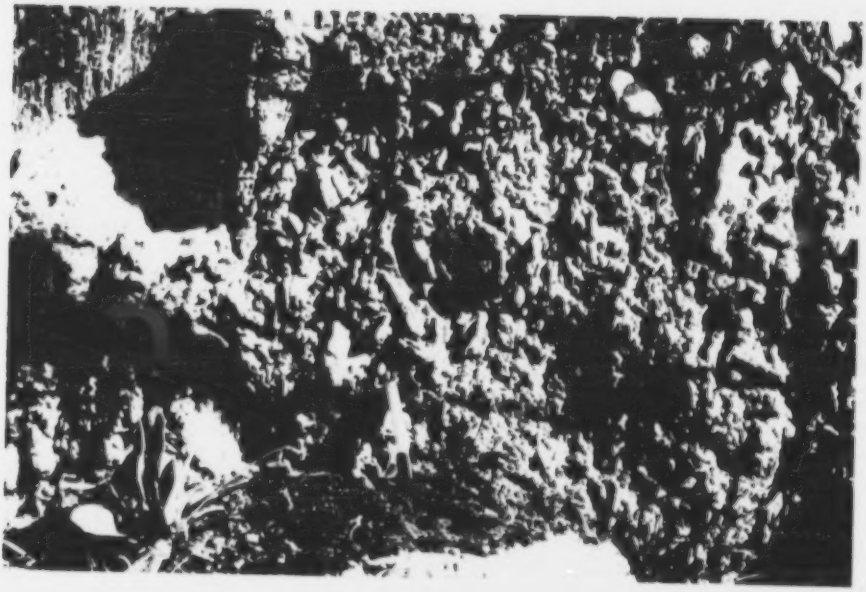

Photo 6. *Carbonate pebble metaconglomerate, map unit 6h.*

One to five metre wide bands of fine grained hornblende-biotite-oligoclase rock and coarse grained hornblende-plagioclase rock of massive appearance, possibly a mafic sill, occur symmetrically in the northern part of the middle metaconglomerate band and in the southern part of the southern metaconglomerate band, suggesting that the conglomerate layers were multiplied and thickened by folding.

Impure marble containing phlogopite and tremolite, and showing its fragmental-brecciated nature only on the weathered surface, occurs along the northern contact of the felsic fragmental metavolcanic unit (2a). The contact zone between the marble unit (6) and the felsic fragmental metavolcanic unit (2a) consists of a 1 to 5 m wide zone comprised of the fragmented-brecciated impure marble unit described above and a white to light grey plagioclase-quartz-muscovite±pyrite quartzite, followed by thick fragmental felsic metavolcanics to the south, and by marble (unit 6) to the north. In general, the complete sequence of this contact zone is poorly exposed, but since fragmental marble has been found in four distinct separate locations along this contact, it is suggested that this narrow layer is continuous.

Banded phlogopite-diopside-tremolite marble outcrops 400 m southwest of the southern tip of Palmerston Lake. The marble is weathered and practically decomposed to limy sand. It contains oval-shaped nodules consisting of large accumulations of calc-silicate minerals. These nodules are believed to have been produced by brecciation in the core of a small fold structure.

Clastic Metasediments

Gneisses, considered to be metamorphosed equivalents of siliceous and calcareous clastic sediments, occur in northeast trending belts between the carbonate metasediments (unit 6) in three areas. The subdivision of the clastic metasediments into three units is based on the difference in mineral composition of the units, and the fact that all three of the individual units occur in the three different locations where clastic metasediments were observed.

Unit 7a is confined to the two narrow northeast trending bands near the village of Plevna. The bands consist of fine grained, medium grey gneiss which is fairly uniform throughout all of the exposures. A thin sectioned sample reveals a fine grained homeoblastic matrix of quartz, carbonate, and plagioclase, with subparallel flakes of biotite and muscovite. Small non-oriented porphyroblasts of biotite and muscovite are post-tectonic. Sheet silicate minerals comprise 35 to 40% of the rock. The rock contains about 7% magnetite and accessory amounts of tourmaline. Up to 5 mm long, subparallel oval-shaped spots are seen in polished sample; however, a thin section shows only poikiloblasts composed of dense micaceous and chloritic material.

Lithic sandstones, lithic calcareous sandstones, and lithic mudstones comprising unit 7b extend, in the northeasterly striking antiforms and narrow infolds in marble, from the village of Fernleigh in the southwestern part of the map area to the north central part of the map area. Although all of these rocks carry the assemblage quartz-plagioclase-orthoclase or microcline-biotite-carbonate, variations do occur due to the different amounts of biotite and due to different fabrics. These rocks are usually fine grained and display colour shades of grey and pink; biotite-rich varieties are dark grey to black. Variety in the mineral fabric can be described as: gneissic, laminated, finely laminated, pinch-and-swell laminae, and schistose. The subparallel arrangement of micaceous minerals defines the foliation. Lamination is produced by the alternating layers of different mineral composition and or/grain size. Fabric of the felsic minerals is fine grained to medium grained and granoblastic to heteroblastic. Segregation bands of the following compositions are common: quartz, quartz+feldspar, carbonate, quartz+muscovite, biotite+muscovite. Post-tectonic growths of muscovite and biotite were encountered in three thin sectioned samples. Numerous garnet porphyroblasts are confined to the biotite-rich layers. Minerals present in accessory amounts are tourmaline, apatite, and magnetite.

Layers of dark grey thinly laminated quartz-plagioclase-biotite-muscovite-carbonate-magnetite-garnet semischist outcrop on the southern limb of the antiform between Swaugers Lake and Highway 506. Rivers (1976) suggests that this horizon, as well as the adjacent finely laminated marble, resulted from the recrystallization of mylonites. Mineral composition and rock textures suggest that they originated from quartzo-feldspathic calcareous sandstone with interbeds of argillite to limy mudstone.

White to white-grey, fine grained, poorly foliated pyrite-muscovite-quartz-plagioclase siltstone outcrops discontinuously in a narrow horizon between marble (unit 6) and the felsic fragmental metavolcanic unit (2a) northeast of Ardoch Lake. The rock consists of narrow homogeneous layers of granoblastic-polygonal plagioclase and quartz alternating with heteroblastic layers of poorly shaped plagioclase and quartz. Plagioclase in the latter layers is strongly sericitized. Minor phases, constituting together about 10% of the rock, are muscovite, biotite, and microcline. A large variety of accessory minerals includes apatite, zircon, needles of rutile, limonitized pyrite, and sphene. One outcrop of this rock type was found at the southern contact of the felsic fragmental metavolcanic unit 2a.

METAMORPHOSED MAFIC INTRUSIVE ROCKS

Gabbro Complex

Although found in large bodies in neighbouring Dalhousie and Lavant Townships, mafic intrusive rocks form only one relatively small body in the map area. A stock of gabbro-diorite composition (3x2 km) intrudes the metasediments south of Plevna and occupies the core of the Plevna Synform. The rocks are well exposed for about 2 km along Highway 506. The body is inhomogeneous in composition and contains a variety of phases, ranging from gabbro to granodiorite in composition. The dominant rock type in this unit is of gabbroic composition, displaying a variety of massive textures (medium to coarse grained gabbroic and diabasic texture) and also, in the fine grained biotite-rich parts of the body, a poorly foliated fabric.

Photo 7. *Brecciation in gabbro-diorite complex, map unit 8a.*

Thin sections of the coarse grained gabbro with diabasic texture contain lath-shaped, strongly sericitized, remnant grains of plagioclase and large non-equant grains of hornblende. Fine grained granoblastic plagioclase has fully replaced small original grains of plagioclase, while the large original grains of plagioclase are replaced only along their borders and fractures. Relict grains of plagioclase showing albite and albite-Carlsbad twinning are zoned with a compositional range from An_{30} to An_{42}. Diabasic texture, noticed in hand specimen, was not discernable on a microscopic scale. Common accessory minerals are apatite, biotite, magnetite, and sulphide mineralization.

Porphyroblasts of garnet commonly occur in many outcrops in hornblende-rich and biotite-rich phases. Remnants of hypersthene mantled by hornblende were recorded by Rivers (1976). Light coloured varieties contain up to 40% quartz, greater amounts of biotite and oligoclase, and show a similar, non-oriented to poorly oriented fabric. They are present as a system of crisscrossing, irregular, pinch-and-swell structures within the main gabbroic complex.

At the contacts of the intrusion with the gneisses (units 4, 5), the intrusion is fine grained, foliated to schistose; and along the margins, blocky inclusions of neighbouring mafic and felsic gneisses occur. Evidence of a thermal aureole is the hornfelsic nature of the hosting gneisses in the contact zones. Locally, brecciation occurs mainly near the borders, with angular mafic fragments cemented by felsic material (Photo 7).

Mafic Sills and Dikes

Although not common, small, mafic, mostly concordant intrusions of dikes and sills (unit 8b), ranging from 1 to 5 m in width, are scattered throughout the map area. Larger diabasic sills (50 to 120 m in width) occur in the marble unit south and east of Cards Lake and within the clastic metasedimentary unit (7b) 1600 m west of Swaugers Lake.

METAMORPHOSED FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Northbrook Batholith

The Northbrook Batholith is a large intrusive body which extends for about 50 km in a northeasterly direction from the Northbrook area (southwest of the map area) to the Donaldson area (northeast of the map area). In the Northbrook area, the body is known as the Northbrook Batholith, while within the map area the name Cross Lake Gneiss has also been used (Smith 1956). The Northbrook Batholith covers about 100 km^2 in the southeastern part of the map area.

Two narrow, northeast trending, continuous belts of Hermon Group metavolcanic rocks occur within the Northbrook Batholith, and the third belt of metavolcanic rocks borders the body along its northwestern edge. Most parts of the body display prominent lineations and gneissosity which are marked primarily by the alignment of biotite and hornblende. Locally, the coarse grained varieties may be massive.

Within the map area, there are three major types of contacts between the Northbrook Batholith and the Hermon Group:

1. A "concordant zone" characterized by alternating 1 to 3 m thick concordant bands of metavolcanic rocks and orthogneisses. Orthogneiss bands are fine grained, whereas bands of metavolcanic rocks are relatively coarse grained and both rock types are well foliated. This zone of alternating bands is usually 10 to 20 m wide.
2. A zone, marked by irregular inclusions of metavolcanic rocks within the orthogneiss.
3. A zone of banded migmatites, displaying alternating bands of metavolcanic rocks and orthogneisses.

The variation in the nature of the contacts may be a function of the volume and therefore temperature of the intrusion, which is considered by the author to have intruded the metavolcanic rocks in sheet-like fashion. The original structure of the host rocks also played an important role in the character of the contact zones. A few narrow bands of metavolcanic rocks form concordant inclusions within the Northbrook Batholith. In the northeastern corner of the map area, the contact with the Hermon Group is poorly exposed and obliterated by large numbers of pegmatite intrusions.

Trondhjemite Gneiss, Granodiorite Gneiss

The most widespread rock type is white to light grey, medium to coarse grained gneiss consisting typically of oligoclase (50%), quartz (25-30%), biotite (10-15%), and microcline (5%), with minor hornblende, sphene, apatite, epidote, and magnetite. In some species, equal amounts of hornblende and biotite are present. Plagioclase has subidioblastic to xenoblastic form, whereas quartz is only xenoblastic and strongly strained. Recrystallization of quartz under strain to granoblastic grains was evident in one sample. Microcline forms small interstitial-like grains and myrmekitic texture is often developed in plagioclase at its contact with microcline. The lineation and gneissosity are defined by the alignment and segregations of biotite and biotite-hornblende. Smith (1956) reported a pink granitic variety south of the village of Ardoch. Microscopically examined specimens from this area did not reveal more than 7% potassium feldspar and the pinkish colour appears to be a reflection of limonite staining. Three thin sectioned samples revealed a trondhjemitic composition; however, in the field, rocks of granodiorite composition were identified.

Feldspar Porphyry Dikes and Sills

Small, 3 to 5 m wide, felsic dikes of concordant character occur in several marble (unit 6g)-amphibolite (units 3c,d) outcrops in the area between the village of Ardoch and the Kashwakamak Lake area. These rocks consist of a fine grained, buff to grey weathering matrix with numerous white tabular grains of plagioclase up to 5 mm in size. The matrix consists of fine grained granoblastic quartz,

plagioclase, and carbonate with flakes of biotite and muscovite. Muscovite, carbonate, and granoblastic quartz replace the original phenocrysts of plagioclase along the edges. The rock displays non-oriented to poorly foliated fabric.

Medium grained, foliated, pink quartz monzonitic gneisses (map unit 9c) outcrop along the eastern map boundary east of Big Black Bay. This map unit is part of the metamorphosed monzonite-granite pluton which was described by Smith (1958) as the Lavant Gneiss.

Coarse Grained Migmatite with Potash Feldspar-Quartz Segregations

Unit 9c is a leucocratic, very coarse grained, banded migmatitic quartz-microcline-plagioclase gneiss. It occurs as a concordant lens-shaped body (500 x 1600 m) within the southern band of the Hermon Group metavolcanics east of Little Black Bay. Banding in the migmatite parallels the regional strike of the metavolcanics. The rock is composed of alternating bands, 0.5 to 2 cm thick, that differ in colour, grain size, and mineralogy. Blue-grey bands consist of coarse, elongated, strongly strained, xenoblastic grains of quartz; small amounts of aligned muscovite and biotite form inclusions within the large quartz grains. White bands are medium grained and consist of granoblastic grains of quartz and plagioclase with minor amounts of biotite and muscovite. Pink bands of pegmatitic character are medium to coarse grained and consist of quartz-potassium feldspar.

Abinger Pluton

Only a small part of the granitic Abinger Pluton (Rivers 1976) is present in the northwestern corner of the map area. Along the contact of the Abinger Pluton with host rocks, a 10 to 30 m wide migmatitized zone is developed.

Muscovite±Biotite Granite Gneiss

Within the map area, the granitic Abinger Pluton is principally represented by pink to white-pink, fine grained, poorly foliated gneiss (unit 10a). The dominant minerals are quartz, potassium feldspar, and plagioclase, with minor biotite, muscovite, epidote, and accessory amounts of sphene and pyrite. Quartz comprises about 30% of the rock and biotite+muscovite do not exceed 7%. Quartz is present in two habits: as larger (1 mm) strained grains and as small (0.10 to 0.15 mm) granoblastic grains. Orthoclase has an irregular form whereas plagioclase displays a lath shaped to tabular habit. Both feldspathic phases are strongly sericitized. The rock has a poorly developed foliation because of its low phyllosilicate content.

Fine-Grained Leucocratic Dikes

Fine grained, pink to white, non-foliated to poorly foliated, leucocratic rocks of granitic composition form small intrusions in the northern and southern limbs of Plevna Antiform south of Larby Lake, southeast of Abs Lake, and west of Cards Lake.

FLINTON GROUP

The Flinton Group is a formally defined largely metaclastic succession. It postdates all of the above described units. The following three formations of the Flinton Group (Moore and Thompson 1972, 1980) are present in the map area: (1) Bishop Corners Formation, (2) Myer Cave Formation, and (3) Fernleigh Formation.

In the map area, the most extensive and continuous exposures of the the Flinton Group are confined to two narrow northeasterly striking (075°) synclinal structures, the Fernleigh and the Ompah Synclines, in the central part of the region. A narrow northeasterly trending zone of pelitic schists exposed along the power line northwest of Little Green Lake also forms part of the Flinton Group (Moore and Thompson 1972, 1980). A narrow band of strongly deformed and migmatized Flinton Group conglomerate occurs in the southeastern corner of the map area. There, the conglomerate has been infolded with the metavolcanics of the Hermon Group and lies in a synformal-antiformal structure. The conglomerate that lies on

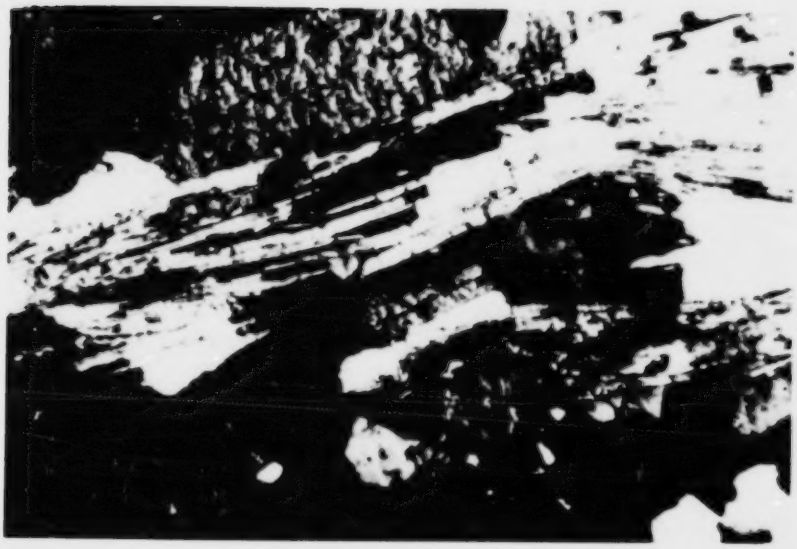

Photo 8. *Photomicrograph of sillimanite-garnet-muscovite-quartz schist, Bishop Corners Formation, map unit 11a.*

the southern limb of the antiform has been traced along strike for about 5 km in the direction of decreasing metamorphic grade, to where its conglomeratic texture is better preserved. It is likely that this conglomerate band extends further to the southwest, i.e. along the southern border of the Northbrook Batholith, and probably joins with the Flinton Group conglomerate in the Kaladar Area (Wolff 1978).

The Fernleigh Syncline contains all of the rock units of the formations within the Flinton Group with the exception of unit 11d. The Ompah Syncline and the synformal-antiformal structure in the southeastern corner of the map area contain only the rock units of the Bishop Corners Formation.

Bishop Corners Formation

Lithologic members of the Bishop Corners Formation in the map area comprise pelitic schist (unit 11a), calcareous quartzite (11b), quartzite pebble metaconglomerate and polymictic metaconglomerate (unit 11c), and hornblende-biotite schist (unit 11d).

Map unit 11a is a grey to silver-grey, fine to coarse grained, micaceous schist. This pelitic schist is considered to be the basal member of the Bishop Corners Formation (Moore and Thompson 1980). It is strongly schistose and frequently porphyroblastic. Locally, narrow bands showing compositional layerings are present. Principal minerals of the matrix are quartz, muscovite, and opaque minerals (magnetite, hematite); other matrix minerals are biotite and plagioclase. Opaque minerals may constitute up to 10% of the rock and tourmaline is an ubiquitous accessory mineral. A variety of common porphyroblastic minerals occurring in this unit in the map area include staurolite, kyanite, oligoclase, garnet, biotite, sillimanite, and magnetite (Photo 8). Large (2-5 cm) porphyroblasts of staurolite, kyanite, and oligoclase are locally present. This map unit is exposed in a narrow (100 m and less) almost continuous zone on the northern limb of the Fernleigh Syncline, and in narrow northeast trending infolds northwest of Little Green Lake and north of the village of Fernleigh respectively.

Calcareous quartzite (unit 11b) is confined to the core of the Ompah Syncline. The rock weathers a buff-pinkish white and displays fine grained texture. The original bedding is preserved and faint cross bedding is present in some outcrops. The rocks consist of quartz (70%), carbonate (10%), muscovite (10%), biotite (5%), microcline (5%), and accessory amounts of opaque minerals. Texturally, this rock is granoblastic with a weakly defined foliation which appears to be along relict bedding planes. Impure calcitic marble forms only a narrow layer within the calcareous quartzite in the northeastern part of the Ompah Syncline.

Smith (1956) depicted an overturned sequence from top determinations in the crossbedded quartzite on the southern limb of the structure and defined the structure as a syncline.

Large exposures of quartzite pebble metaconglomerate and polymictic metaconglomerate (unit 11c) are present in the Ompah Syncline and on the southern limb of the Fernleigh Syncline in the northeastern part of the map area. The heterogeneity of this unit is demonstrated by variations in the matrix mineralogy, proportions of matrix to clasts, and size and composition of the clasts. The clasts are most commonly pebble size (5 to 15 cm) and display flattened elipsoidal shapes. Pebbles are of quartzite, granite, white quartz, marble, and uncommonly of mafic composition (hornblende-biotite schist). Pebbles of quartzite are buff to dark grey in colour and generally fine grained. Granitic pebbles are reported (Smith 1956) to contain substantial amounts of potassium feldspar, thus bearing resemblance to the Lavant granite gneiss, which occurs northeast of the map area. Pebbles of hornblende-biotite schist are difficult to distinguish from the dark matrix of similar composition, and pebbles of marble often appear as a coarser part of the matrix. The proportions of matrix to clasts and the composition of the pebbles vary from outcrop to outcrop; locally, layers containing no pebbles were encountered. Smith (1956) noted that the size of pebbles decreases from the west to the east and that the marble pebbles are more common in the eastern part of the syncline than in the west. Rivers (1976) made the observation that the clasts of boulder size are invariably of granitic composition set in a matrix of biotite schist, and that where clasts are predominantly of calcite, the matrix is rich in hornblende. The composition and the grain size of the matrix is also variable. Generally, a dark matrix consisting of different proportions of hornblende and biotite predominates. A pelitic matrix of muscovite-biotite schist and a quartzite matrix are limited to a few outcrops in the Ompah Syncline.

Thin section study of the schistose hornblende-biotite matrix revealed plagioclase (An_{46}), biotite, hornblende, quartz, and small amounts of carbonate and magnetite. Hornblende also occurs as porphyroblasts. Porphyroblasts of garnet are generally confined to rocks with the biotite-hornblende matrix. A thin sectioned sample of hornblende-carbonate matrix contained carbonate, hornblende, myrmekitic plagioclase, scapolite, epidote, and diopside.

The conglomerate exposed in the synformal-antiformal structure in the southeast corner of the area is strongly deformed and its conglomeratic texture is poorly preserved. In the core of the synform, it resembles a leucocratic gneiss and is composed of 0.5 to 2 cm thick alternating bands of bluish-grey, white, and pink colour.

The bluish-grey bands are comprised of coarse, elongated and strongly strained granoblastic grains of quartz. Small aligned grains of biotite and muscovite form inclusions within the large grains of quartz. The white bands are medium grained and consist of granoblastic quartz and plagioclase with subordinate biotite and muscovite. The pink bands are medium to coarse grained, pegmatitic, and are composed of randomly oriented grains of quartz and potassium feldspar. They have probably been injected into or mobilized from the original sedimentary layers. On the limbs of the structure, a narrow band of strongly deformed polymitic and migmatized conglomerate is present. It consists of deformed clasts of granite, quartzite, and small mafic clasts set in a matrix of coarse grained quartzite. Where the conglomerate overlies the metavolcanic rocks, it contains many mafic clasts and the quartzose matrix carries hornblende, diopside, and epidote instead of biotite and muscovite.

Biotite-hornblende-plagioclase±carbonate schist (unit 11d) is present in the core of the Ompah Syncline in the extreme northeastern part of the map area. Compositionally and texturally it resembles the hornblende-biotite schistose matrix of the metaconglomerate unit (11c).

Myer Cave Formation

The Myer Cave Formation in the map area comprises graphite±pyrite schist (unit 12a), marble and dolomitic marble (unit 12b), and carbonate-clast metaconglomerate (unit 12c). Members of this formation are confined to the Fernleigh Syncline.

In the southwestern part of the map area the graphitic-pyritic schist occurs in two narrow horizons along the northern and southern contacts of the marble unit on the northern limb of the Fernleigh Syncline. A few discontinuous layers are also intercalated in the marble unit. Towards the northeast, the horizons of graphitic pyritic schist are thin and become discontinuous, similar to other members of the Flinton Group succession on the northern limb of the Fernleigh Syncline.

The graphitic pyritic schist (unit 12a) is dark grey to black in colour and shows typical rusty weathering. The rock is very fine grained and displays slaty cleavage. One thin sectioned sample of this rock revealed the presence of a large number of mineral phases (muscovite, biotite, quartz, plagioclase, scapolite, diopside, carbonate, apatite, sphene) indicating an original pelitic calc-silicate composition. Finely dispersed graphite is responsible for the black colour of the rock. Fine grained to porphyroblastic pyrite constitutes about 25% of the mineral content of the rock. Foliation is defined by the segregation of the fine grained quartz-pelite and coarse grained calc-silicate layers. In addition, most of the minerals show a certain degree of preferred orientation.

Marble and dolomitic marble (unit 12b) is more prevalent on the northern limb of the Fernleigh Syncline. Wider exposures of this unit are present between the village of Fernleigh and Swaugers Lake. Toward the northeast, the marble unit thins and becomes discontinuous, similar to the other units on the northern limb of the Fernleigh Syncline. Marble and dolomitic marble are uniform in texture, being mostly medium grained, and display grey and white colours and occasionally grey and white layering.

Carbonate clast metaconglomerate (unit 12c) occupies the southern limb of the Fernleigh Syncline from the western end of the structure near the closure of the Ompah Syncline. North of the closure of the Ompah Syncline, the band of carbonate clast metaconglomerate becomes thinner and practically pebble free, and narrow layers of quartzite pebble metaconglomerate appear within marble and carbonate metaconglomerate. Over a short distance, this mixture is replaced by a continuous horizon of quartzite pebble metaconglomerate (unit 11c). The gradation of carbonate clast metaconglomerate to quartzite pebble metaconglomerate is considered to represent a lateral facies change and carbonate clast metaconglomerate is thus the stratigraphic equivalent of the quartzite pebble metaconglomerate (Moore and Thompson 1972).

The carbonate clast metaconglomerate weathers buff to brownish with buff to rusty clasts. The matrix consists of carbonate (dominantly calcite) and minor phlogopite, biotite, quartz, and calc-silicate minerals. Clasts are subrounded to rounded, stretched, and average 5 to 15 cm in length, but are locally up to 30 cm in maximum dimension. The clasts are principally of dolomite, calc-silicate bearing dolomite, and minor quartzite. Locally, pebble-free layers consisting of fine grained, grey-white marble demonstrate the presence of original bedding.

Fernleigh Formation

The Fernleigh Formation occupies the core of the Fernleigh Syncline and overlies all of the preceding Flinton Group units. This formation is fairly uniform and consists principally of rhythmically bedded schistose biotite-carbonate rocks. The individual layers are from 0.2 to 8 cm thick. These rocks weather dark brown to rusty brown, are fine to medium grained, and have a strong foliation. Between the

villages of Fernleigh and Ardoch, the bedding is locally preserved and graded beds with carbonate-rich tops are encountered in places.

A thin sectioned sample from the Fernleigh area consists of alternating fine grained, biotite-rich layers (biotite, quartz, carbonate—in decreasing order of abundance) and coarser grained, carbonate rich layers (carbonate, quartz, biotite—in decreasing order). Small post-deformational poikiloblasts of muscovite and accessory tourmaline are confined to the biotite-rich layers.

From the southwest to the northeast, the mineralogy of the calc-silicate layers changes as the rocks have been subjected to progressively increasing temperatures and pressures. The carbonate-quartz assemblage gives way to scapolite-tremolite along the Ardoch Road, and to diopside-scapolite northeast from Big Island on Mud Lake. Also, hornblende and plagioclase become prominent phases in the latter location.

MIDDLE AND LATE TECTONIC FELSIC INTRUSIVE ROCKS

Pegmatite dikes and sills, spatially related to the Northbrook Batholith and the granitic Abinger Pluton, are abundant within the map area. The dikes and sills have sharp contacts and cut across the foliation in the host rocks or intrude parallel to the developed foliation in the host rock. Locally, blocks and pieces of country rock are included and/or assimilated in pegmatite. These rocks, showing no evidence of recrystallization and deformation, were emplaced after the culmination of the regional metamorphism and accompanying deformation. The mineralogy of the rocks consists of feldspar (either microcline, or sodic plagioclase), quartz, accessory biotite, muscovite, tourmaline, and magnetite. Pegmatites vary greatly in grain size, a pink variety is dominant in the map area and graphic texture is rarely seen.

Pegmatite dikes (unit 14a) and swarms are largely hosted by the Northbrook Batholith and by the granitic Abinger Pluton. They cut and intrude these host rocks irregularly or intrude them along joints. Several small dikes of white pegmatite, containing tourmaline crystals, cut through marble (unit 6) and quartzo-feldspathic biotite gneiss (unit 7b) north of the contact with the pelitic schist of the Bishop Corners Formation, in the area to the north and northeast of Mud Lake. Two small pegmatite dikes were encountered in the Flinton Group in the Fernleigh area and in the Ompah Syncline area.

Pegmatite sills (unit 14b) form a prominent part of the outcrop in the Cross Lake area and in the border zones of the Northbrook Batholith in the northeastern corner of the map area. Here, pegmatites intrude along the foliation of the metavolcanics of the Hermon Group. In some areas, their volume exceeds the volume of the host rock. Many of the pegmatites occurring in these areas carry uranium mineralization. Pegmatite sills also occur in the border zones of the Abinger granitic pluton.

PHANEROZOIC

CENOZOIC

Quaternary

Pleistocene and Recent

The Pleistocene deposits in the map area are represented by a variety of glacial drift. Silty to gravelly glacial till deposited by ground moraine forms thin and discontinuous cover throughout much of the map area. Thicker accumulations are found only in the valleys. Thicker and better sorted accumulations of sand and gravel, deposited by the glaciofluvial streams, are presently being extracted by local operators from the outwash plain deposits north of the villages of Plevna and Ardoch, and in the area of Cross Lake. Gravel deposits south of Palmerstone Lake represent kame and kettle terrain.

The recent deposits in the map area are represented by organic swamp and alluvial deposits. The swamps occupy the fault and fracture zones parallel to the joints and regional strike-controlled terrain depressions. The most widespread

swamps controlled by strike are usually narrow (up to 1 km across) but continuous along strike. These contain prominent lake systems, including Mud Lake and the Kashwakamak-Malcolm-Ardoch Lake system. Recent alluvial deposits are associated with these swamps and include minor stream sediments.

METAMORPHISM

All of the rock units, with the exception of units 14a and 14b, have undergone regional metamorphism during the Late Precambrian (Proterozoic). Of the large number of rock compositions which exist within the map area, the most sensitive to changes in pressure and temperature are the pelitic, mafic, and calc-silicate rocks. The quartzo-feldspathic rocks, dominant in the northwestern half of the map area, carry the mineral assemblage quartz-muscovite-biotite-plagioclase-microcline throughout.

The metamorphic mineral assemblages in these rocks indicate that within the map area the pressure-temperature conditions of the almandine-amphibolite facies have been reached, and that the metamorphic grade increases northeastward. Considerable work has been done on the metamorphism within and west of the map area and this section compiles information published by Moore (1967), Moore and Thompson (1972), Sethuraman and Moore (1973), Rivers (1976) and the author's observations.

Based on the mineral assemblages in the pelitic schists of the Bishop Corners Formation, two metamorphic zones: (1) a staurolite-kyanite zone, and (2) a sillimanite zone were established within the map area.

The staurolite-kyanite zone, represented by the mineral assemblage staurolite-kyanite-muscovite, persists from the western limits of the map area to the Ardoch Road-Highway 506 junction, where it gives way to the assemblage sillimanite-muscovite.

At the sillimanite-muscovite isograd, the first appearance of sillimanite is in the form of fibrolite only, in isolated pods and in association with a few poorly formed grains of staurolite and/or kyanite. Northeastwards, the staurolite and kyanite cease and well formed sillimanite and muscovite are the only alumninosilicates present. Rivers (1976) reported the occurrence of sillimanite-potassium feldspar in the area of Clyde Forks, about 15 km northeast of the northeastern map limits.

The mafic and intermediate metavolcanics in the southeastern part of the map area bear the mineral assemblage plagioclase-hornblende-biotite-quartz. Sethuraman and Moore (1973) studied the metamorphic zonation in these rocks between the villages of Bishop Corners (14 km west of the map area) and Donaldson (1 km east of the map area) and distinguished five zones: chlorite, biotite, blue-green hornblende, green hornblende, and diopside. All of the metavolcanics within the map area are at the highest, diopside zone. The authors indicated that diopside is first present only in isolated pods and lenses, and northeastwards it is present more consistently. Four thin sectioned samples selected by the author from these metavolcanics in southwestern and central parts of the map area did not contain any diopside, suggesting erratic presence of diopside within parts of the map area. Diopside becomes a prominent mineral of the metavolcanics in the area around and northeast of Kings Lake. The mineral assemblages carbonate-quartz-tremolite and carbonate-quartz-diopside, recorded in the calc-silicate rocks in this order from the southwest to the northeast, indicate the same, northeasterly prograding metamorphic trend.

A change in the composition of the gneisses of the Northbrook Batholith from muscovite-biotite gneiss in the west to hornblende-biotite gneiss in the east was recorded by Chapman Kamilli (1974) and attributed to progressive metamorphism. Relict primary textures, occasionally present in the west, are completely eliminated in the northeast.

Based on the lack of a separate kyanite zone, combined with the presence of some significant mineral assemblages in the metavolcanics and the pelitic schists, Sethuraman and Moore (1973) concluded that the rocks to the west and within the map area were formed at somewhat lower pressure, and that the rocks recrystallized under pressure-temperature conditions between low pressure metamorphism of the Abukuma-type facies series and the intermediate pressure metamorphism of the Barrovian-type facies series.

The evidence that the metamorphism outlasted the deformation is demonstrated by a large number of post-tectonic crystal growths, and on the regional scale by the transective character of the metamorphic zones.

STRUCTURE

REGIONAL SETTING

The map area lies within the Central Metasedimentary Belt (Wynne-Edwards 1972) and specifically within the IVb segment in the eastern Hastings Basin, and forms the northern part of the Kaladar-Dalhousie Trough (Hewitt 1956). In the Ardoch Area, the northeast trending belt of metavolcanic and metasedimentary rocks is surrounded by the plutonic bodies of the Northbrook Batholith in the southeast, and by the Abinger granitic pluton in the northwest. All stratigraphic units, including the plutons and the Flinton Group, have been folded into a system of synforms and antiforms which trend 050° to 055°.

FOLIATION, LINEATION

As a result of deformation and recrystallization, most of the rocks within the map area exhibit some degree of planar and linear fabric or a combination of both. The terms foliation, schistosity, gneissosity, and lineation are used to describe planar and linear fabric in the rocks as marked on the accompanying map sheet (back pocket).

Foliation is a broad term. In metamorphic rocks, it refers to a parallelism of fabric that induces planar fissility in the rocks. In the metavolcanic tuffaceous rocks and in the metasedimentary rocks, the spacing of the foliation planes often reflects the original stratification of these rocks.

Schistosity is a type of foliation, developed in mica-rich or amphibole-rich rocks, characterized by strong alignment of the tabular and platy micaceous or prismatic amphibole minerals. Highly recrystallized rocks derived from shales or limy mudstones show schistose fabric. In the map area, the schistose fabric is developed mainly in the pelitic schists (mudstones, shales).

Gneissic structure is characterized by alternating layers of differing mineral composition; these layers are usually rich in quartz-feldspar minerals and the rocks display poor fissility. Within the map area, this type of structure is typically developed in the deformed plutonic rocks and migmatites.

Lineation results from the parallelism of some directional property imprinted in the rock. In the map area, lineation is recorded for most of the rock types, except for some of the massive, coarse grained plutonic rocks.

During field mapping, the lineations recorded on the geological map were recorded from the oriented prismatic minerals in the metavolcanic rocks, oriented quartz-feldspar aggregates in the metavolcanics and felsic metasedimentary and plutonic rocks, and from rodding of clasts in the metaconglomerate. Attitudes of minor fold axes and rarely seen attitudes of the cleavage-bedding intersections were also recorded as lineations.

In the Northbrook Batholith, lineation is exhibited as an orientation of quartz-feldspar aggregates and by oriented tabular crystals of biotite.

The Abinger granitic pluton and the gabbro-diorite complex show the least foliated or lineated fabric and may in places be massive.

FOLDS

The rock distribution pattern in the Ardoch Area reflects a complicated history of deformation, plutonism, and metamorphism typical of the Grenville Province. The pre-Flinton history of plutonism and accompanying deformation and metamorphism has been obscured by subsequent phases of post-Flinton deformation. All the rocks within the map area, including the younger Flinton Group, have undergone two major phases of post-Flinton deformation which produced megascopic to mesoscopic scale folds; the third phase produced only mesoscopic structures.

The first post-Flinton phase of deformation (D1) generated northeast trending isoclinal to recumbent folds. Associated axial planar foliation is penetrative and parallel to, or nearly parallel to, the bedding. The megascopic structures attributed to D1 occupy a northeast trending belt between the village of Fernleigh in the southwest and the village of Ompah in the northeast. The Fernleigh and Ompah

Synclines are defined by the outcrop pattern of the Flinton Group metasedimentary rocks, whereas other narrow structures, adjacent to the Fernleigh Syncline in the northwest and southeast, are defined by the outcrop pattern of older metasedimentary and metavolcanic gneisses.

The long narrow Fernleigh Syncline is exposed for about 40 km between the village of Bishop Corners located southwest of the map area and the village of Folger located northeast of the map area. It is an upright structure with steep (70° to 80°) northwest dipping axial plane foliations. The whole structure thins to the northeast. The Fernleigh Syncline has been defined as a synclinal structure by Moore and Thompson (1972) from top determinations in crossbedded quartzite, some 14 km west of the map area. Within the map area, the syncline does not have bilateral lithological symmetry due to transverse as well as lateral facies change (Moore and Thompson 1972). In the map area, the Fernleigh Syncline plunges (10°) to the northeast with minor plunge reversals to the southwest in the area east of the Ardoch Road-Highway 506 junction. It is an upright structure with steep (70° to 80°) northwest dipping axial plane foliations. The whole structure thins to the northeast.

Closely adjacent to the Fernleigh Syncline is the Ompah Syncline in the northeast part of the map area. The Ompah Syncline is defined by the outcrop pattern of the rock members of the Bishop Corners Formation. Smith (1956, 1969) identified the structure as a syncline, overturned to the north, based on top determinations in the crossbedded quartzite of the Bishop Corners Formation. There is a connection between the metaconglomerate unit of the Ompah and Fernleigh Synclines through the narrow tight anticline. The long axes of the deformed clasts paralleling the fold axes dip 10° to 25° northeast, and the axial plane foliations dip 65° to 75° southeast.

The presence of an angular unconformity between the Flinton Group rocks and the underlying older sequence, which was demonstrated by Moore (1967) and Moore and Thompson (1972) in the Bishop Corners area (13 km beyond the western limits of the map area), is difficult to observe within the map area. Deformation, accompanied by the relatively high grade of metamorphism, has obliterated the nature of the contacts between the underlying and overlying units.

Smith (1969) infers the unconformity between the Ompah Syncline suite and the marble from the contrast in structural style between the rocks of the Ompah Syncline and the underlying metasedimentary rocks, and from the different attitudes of the units.

A wider unit of felsic metavolcanic rocks bordering the Cross Lake Antiform to the north is fairly homogeneous in composition and lacks mappable subunits. Its synformal structure is inferred from the identical rock sequence along its northwestern and southeastern contacts consisting of marble, a narrow band of fragmental marble, and white quartz plagioclase metasandstone. Narrow bands of marble, metasandstone, and mafic metavolcanics have been infolded in this unit. The structure has a northeast trend and plunges gently (15° to 25°) to the northeast.

Mesoscopic isoclinal to recumbent folds attributed to D1 are present in the hinge region of the Plevna Antiform and other parts of the map area.

Large scale, open fold structures generated during the second phase (D2) of deformation are dominant in the southeastern and northwestern parts of the map area. The map pattern in the southeastern part of the map has a complicated history of plutonism and folding.

The Northbrook Batholith intruded the metavolcanic units in a series of sheets. Subsequent deformation gave rise to a domal structure mantled by the metavolcanic rocks. Within the map area, the gneisses of the Northbrook Batholith form a core of the northeasterly trending, doubly plunging antiform. The limbs are outlined by the mafic to felsic metavolcanic rocks. The antiform plunges 5° to 12° northeast and steepens near the northeastern fold closure. Reversal of the plunge to the southwest is recorded in the Pine Lake area, to the west of the map area, and from there to the southwest the lineations recorded by Moore and Morton (1980) dip

consistently to the southwest. The foliation and lineation in the Northbrook Batholith are parallel to the enclosed metavolcanic phases.

In the southeastern corner of the region, the Flinton Group metaconglomerate has been infolded with the underlying supracrustal rocks, and the Northbrook Batholith, into a synformal-antiformal structure. At least two episodes of deformation are evident here. The synform is defined by the outcrop pattern of metavolcanics and metaconglomerate; the antiform has a core of Northbrook Batholith rocks around which the supracrustal rocks and metaconglomerate have been deformed. A part of the southern limb of the antiform lies beyond the eastern boundary of the map. Both structures trend 045° to 035° and plunge about 25° to the northeast.

Large and open fold structures of the Plevna Synform and Antiform attributed to D2 are dominant structures in the northwestern part of the map area. They are defined by the outcrop pattern of the mafic and quartzo-feldspathic gneisses and by marble, which is the principal rock type in their cores. The axial plane foliations are steeply dipping (65° to 85°) to the northwest and southeast. Like all other major structures in the map area, the fold axes of the Plevna Synform and Antiform are northeasterly trending and plunge 30° to 40° to the northeast. A gabbro-diorite stock set in the hinge region of the Plevna Synform bears evidence of the same deformation as the host rocks.

The second phase of deformation (D2) is coaxial with the first phase of deformation (D1), and the strong axial foliation developed during D1 is the dominant foliation in the area. Mesoscopic isoclinal to recumbent D1 folds are more widespread in the northwestern part of the map area than in the Northbrook Batholith area in the southeast, which in part is a reflection of different ductility and competency between the rock units in the respective areas.

FAULTS

The most prominent fault in the area is expressed by the 40 m of vertical elevation on the northwesterly striking (120° to 135°) Plevna Fault. A small (300 m) lateral displacement is recorded only in the Cross Lake area. It is a normal fault parallel to the Ottawa-Bonnechere Graben system (Kay 1942) and is probably controlled by the regional system of joints.

A subparallel lineament is present 6 km east of the Plevna Fault, but there is no stratigraphic or structural discordance to substantiate faulting and it has not been shown on the map. The abrupt attenuation of the felsic metavolcanic unit (2a) east of Ardoch Lake is attributed to a folded contact rather than a fault contact. Mapping the exact contact of marble and the felsic metavolcanic unit was hampered by insufficient outcrop in the swampy terrain around Cross Lake.

Prevailing joints in the map are those paralleling the joints in the Northbrook Batholith (120° to 140°). These control one system of pegmatite dikes in the Cross Lake area, and also dikes of tourmaline pegmatite along the northern border of the Fernleigh Syncline.

A strike-slip fault, the Fernleigh-Clyde Fault, was considered to be present in the pelitic schist on the northern limb of the Fernleigh Syncline by Smith (1956) and in the same position in the area to the west of the map area by Meen (1944). This zone of dislocation was inferred (Smith 1956) from structural and metamorphic contrasts on either side of the zone. Moore and Morton, who mapped the adjacent area southwest of the Ardoch Area, that is, the same area in which the fault zone was identified by Meen (1944), pointed out that there is no evidence of any discontinuity other than the unconformity below the Flinton Group (Moore and Morton 1980). Although the structural contrasts on either side of the Fernleigh Syncline as described by Smith (1956) do exist, they appear to be a result of the difference in the rheological properties of the underlying lithologies.

AEROMAGNETIC DATA

A regional aeromagnetic survey (GSC 1952) covering the map area outlines many of the structural features and correlates well with some of the lithological units. The aeromagnetic pattern of relatively dense spacing delineates synformal and antiformal structures of the Plevna Synform and Antiform, and even the small synformal structure in the northwestern part of the map area has an expression. The close spacing and flux of 1200 to 2000 gammas, outlining the limbs of these structures, is replaced by wider contour spacings and by aeromagnetic depressions in the cores of the structures occupied by marble.

In general, areas occupied by marble, clastic siliceous metasedimentary rocks, and felsic intrusive rocks show wide contour spacing and low flux of 1000-1200 gammas. Dense contour spacing of low flux (1140-1260 gammas) outlines the northern limb of the Fernleigh Syncline, occupied by magnetite-rich pelitic schist and graphitic schist; and the thinning of these units toward the northeast is also expressed by the contour pattern. In the northeastern part of the map area, the dense contour spacing delineates the structure of the Ompah Syncline, and the portion of the southern limb of the Fernleigh Syncline underlain by polymictic metaconglomerate, with biotite-hornblende rich matrix. Remarkably also, a narrow marble-underlain antiform, which separates the metaconglomerate units of the Ompah and Fernleigh Synclines, is expressed as a magnetic depression on the aeromagnetic map pattern.

Mafic tuffs south of Ardoch and the southern belts of the metavolcanics have little aeromagnetic expression. The topographically prominent Plevna Fault does not have any expression in the aeromagnetic pattern. However, east of Little Black Bay, the fault strikes east and is marked by an east trending, oval-like pattern of closely spaced aeromagnetic contours. There is no structural or lithological account for the relatively closely spaced contours in the felsic pyroclastic unit in the northeastern part of the map area.

ECONOMIC GEOLOGY

INTRODUCTION

The Ardoch Area contains a variety of metallic and nonmetallic deposits, but the only significant producer in the area was the Boerth Gold Mine near the village of Ardoch. Minor surface workings for gold, base metals, mica, and marble were active between the late 1800s and 1960s (*see:* "Previous Geological Work and Prospecting Activity"). In 1980, production was limited to extraction of sand and gravel used in local construction.

Metallic mineralization consists mainly of gold, arsenic, copper, iron sulphides, uranium, and small scattered amounts of molybdenum, zinc, nickel, lead, and iron oxide. The known gold, copper, and arsenic occurrences are confined to the stratigraphic units bordering the Flinton Group metasediments. Minor zinc and lead are associated with the carbonate and clastic siliceous metasediments of the older upper Hermon to lower Mayo Groups, and with the quartz dolomite veins in the Myer Cave Formation. Copper-nickel mineralization is found in the mafic to intermediate metavolcanics.

Concentrations of radioactive mineralization are confined to pegmatites hosted by the Northbrook Batholith and metavolcanics in the southeastern part of the map area, and by the Abinger granitic pluton in the northwestern part of the map area. Molybdenum mineralization is limited to pegmatite sills in the northeastern part of the area. Iron oxides occur as accessories in the quartzo-feldspathic metasedimentary gneisses, pegmatites, and pelitic schists of the Bishop Corners Formation, and in the gabbro-diorite complex (unit 8), and rarely as replacements in marble. Iron sulphides are found in many parts of the map area associated with metasedimentary rocks and metavolcanics, and within sheared and brecciated zones.

Nonmetallic mineralization, quartz, feldspar, and mica, occur in pegmatites. Tremolite is confined to the contacts of dolomitic marble with quartzite. Accumulations of large crystals of diopside, tremolite, and actinolite are found within the marble units. The occurrence of kyanite and staurolite is limited to the pelitic schists of the Bishop Corners Formation.

METALLIC MINERALIZATION

GOLD

Gold mineralization is closely associated with the crosscutting quartz veins in the irregular vein system at the Boerth Mine (2), and with the concordant quartz vein system at the James Mine (12) and the Webber property (13), and an irregular vein system at the Cook property (5).

The Boerth Mine gold-bearing mineral association is comprised of quartz-arsenopyrite-tourmaline, with minor pyrite-chalcopyrite and pyrrhotite. Miller (1902) writes that the ore containing tourmaline and arsenopyrite was said to be richest in gold. This is in agreement with the observations of the author. A sample (LBP-0533) collected from the mine dump by field party personnel, with visible chalcopyrite but no tourmaline, assayed 0.5% copper and 1270 ppb gold (Geoscience Laboratories, Ontario Geological Survey, Toronto).

At the James Mine (12), the gold-bearing mineral association is quartz and chalcopyrite, and at the Cook (5) and the Webber (13) properties the gold is associated with quartz and arsenopyrite.

At the Boerth Mine the pyrite, pyrrhotite, and arsenopyrite occur mostly as small disseminated grains in the quartz veins or in the hosting biotite gneiss, whereas chalcopyrite forms small clusters and stringers in the quartz veins. At the Cook property, the arsenopyrite occurs as patches up to 1.5 cm in diameter. Gold mineralization in the map area appears to be widely scattered and many quartz veins found in the neighbourhood of these deposits do not show any traces of mineralization.

With the exclusion of the Cook property, all deposits (2, 12, 13) are hosted by the same stratigraphic and structural unit of carbonate (unit 6) and quartzo-feldspathic metasediments (unit 7b). The isolated Cook property (5), located on the

southern side of the Fernleigh Syncline, is underlain by metamorphosed calcareous tuffs (amphibolite) (unit 3).

Mineralized quartz veins in the map area are confined only to the stratigraphic horizons that are found in the proximity of the Flinton Group metasedimentary rocks. There are a large number of quartz veins in the northwestern part of the map area. These are barren of any macroscopic mineralization. Samples (LBP-0168, LBP-0180, LBP-0220, LBP-0361 and LBP-3026) collected by field party personnel from some of these veins revealed only traces of copper, and 2 to 65 ppb gold (Geoscience Laboratories, Ontario Geological Survey, Toronto).

Auriferous mineralization is confined to late quartz veins which occupy fractures and fissures, or form concordant lenses along the planes of the foliation in the hosts rocks. They were probably emplaced during the waning stages of regional metamorphism as a product of metamorphic dewatering.

A recently discovered gold and silver-bearing silicified zone west of Fernleigh occurs in the same formation that underlies the Boerth Mine. It has been indicated to the author that this showing lies near the contact with the Flinton Group metapelite (personal communication, S.V. Burr, 1980).

Known gold deposits such as the Addington Mine Limited, the Ore Chimney Mine, and several other occurrences found southwest of the map area occur at, or near the contact of, the Flinton Group metasedimentary rocks with the underlying older units (Moore and Morton 1980a, 1980b).

A sample (LBP-0694) collected by the author from a concordant, lens-shaped, marble-hosted quartz vein located on Lot 33, Concession III, Clarendon Township, 800 m northeast from the pit at the James Mine (12), assayed 10.1 ppm gold with traces of copper (Geoscience Laboratories, Ontario Geological Survey, Toronto).

ZINC AND LEAD

Small amounts of lead and zinc mineralization are present in two different settings: (1) As weak, probably stratiform disseminations in marble and interlayered quartzofeldspathic gneisses of the older metasedimentary sequence. One such small showing is found on the property of the Selco Mining Corporation Limited (12); (2) In stratabound quartz-dolomite bearing veins hosted by the marble unit (12b) of the Myer Cave Formation.

A sample (LBP-5208) collected by field party personnel of one of these zones, located on Lot 27, southwestern range, Clarendon Township, assayed 0.04% copper, 0.20% zinc, and traces of lead, gold and molybdenum (Geoscience Laboratories, Ontario Geological Survey, Toronto).

URANIUM AND RARE EARTH ELEMENTS

Uranium mineralization is concentrated in the pegmatites (units 14a,b) that are hosted by the Northbrook Batholith (unit 9a), and the metavolcanics (units 1a,c) in the southeastern part of the map area.

The modes of occurrence of the pegmatites are controlled by the regional structure of the host rock. Within the map area, there are three major modes:

1. As stratabound pegmatites intruding the host rocks along the plane of foliation (pegmatite sills), generally in the metavolcanics or border zones of gneissic rocks;
2. As crosscutting pegmatites intruding the host rocks, generally the gneissic rocks, along the planes of the prevailing system of joints trending 120° to 150°;
3. As irregular, often curving and discontinuous bodies and swarms of pegmatites, showing no common directional pattern, confined to the gneisses of the Northbrook Batholith and to the granitic gneisses of the Abinger Pluton.

Although pegmatites in all three types of occurrence may show considerable radiometric anomalies, the most promising are the metavolcanic-hosted pegmatite sills which in some areas make up 50% of the outcrop within the metavolcanics, and thus bear the potential of larger quantities of radioactive material. Also, their

dimensions are considerably larger, averaging 1.5 to 15 m in width, and 30 to 90 m in length. Pegmatites up to 60 m wide and 185 m long were locally encountered. Magnetite and/or biotite-bearing pegmatites, fractured and sheared zones in pegmatites, and also the contact zones of pegmatites in the intruded rock represent the best potential hosts for uranium mineralization.

Hematization, yellow staining, and red brick coloured alteration are good macroscopic indicators of potential uranium mineralization. Leucocratic coarse grained and graphic textured pegmatites carry the least radiometric anomalies.

It is not clear what kinds of uranium minerals account for the radioactive anomalies. Uranophane and uraninite were described from pegmatite showings in the Cranberry Lake area (Assessment Files Research Office, Ontario Geological Survey, Toronto). One small, dark brown, elongated crystal found in a pegmatite in the Pine Lake area was macroscopically identified by the author as allanite. Field scintillometer surveys of the pegmatites showed a range of from two to seven times background, and locally small very highly anomalous zones were encountered (Assessment Files Research Office, Ontario Geological Survey, Toronto). Results of the radiometric surveys and representative analytical data are given in Table 2.

From the large number of diamond drillholes that intercepted pegmatite zones (0.50-10 m wide) in the area of Cross Lake, the assayed core samples invariably revealed lower uranium concentrations than at surface (Assessment Files Research Office, Ontario Geological Survey, Toronto); thus indicating that the higher concentrations near surface resulted from supergene enrichment.

Pegmatite sills and dikes showing appreciable radiometric anomalies (2 to 6 times background) were encountered within the metavolcanic unit (1c) north of Kings Lake and in the northeastern corner of the map area.

Pegmatite dikes hosted by the gneisses of the Abinger granitic pluton in the northwestern part of the map area show only weak radiometric anomalies; however, higher radiometric anomalies were encountered by the author in pegmatites north of the map area.

A shallow pit and few pegmatite showings were blasted in the area of Kings Lake, but only weak radiometric anomalies were recorded by the author in these workings.

SULPHIDE MINERALIZATION

Widely distributed throughout the map area are a number of small occurrences of pyrite, often accompanied by pyrrhotite, and small amounts of chalcopyrite, and arsenopyrite. They are found as stratiform bands, stringers, patches, and irregular disseminations in the clastic quartzo-feldspathic metasedimentary gneisses (units 5b, 7b), carbonate metasedimentary gneisses (unit 6), and calc-silicate gneisses (unit 4a) of the older formations; and in the graphitic pelitic schist (unit 12a) and some layers of the biotite carbonate schist (unit 13) of the Flinton Group metasediments. Larger accumulations of pyrite in veinlets and seams are found in the fractured and brecciated zones within these units. Two samples (LBP-0414B, LB0-0417) of marble (map unit 6) mineralized with disseminated pyrite and coatings of malachite, collected by the author from the core of the Plevna Synform, assayed up to 0.06% Cu, 0.018% Zn, and traces of gold, silver, lead, and arsenic (Geoscience Laboratories, Ontario Geological Survey, Toronto).

The most prominent occurrence of this type of mineralization is in the stratigraphic unit (6, 7b) that stretches northeasterly from the Fernleigh area to the Little Green Lake area. This unit also hosts the Webber property (13), the Boerth Mine (2), and the James Mine (12).

Pyrite disseminated along the planes of the foliation in quartzo-feldspathic, often limy gneisses (unit 7b), and disseminations of sulphides (pyrite, pyrrhotite, chalcopyrite) in impure siliceous marble were encountered in many places within this unit, mainly between Highway 506 and Little Green Lake. Samples (LBP-0760, LBP-0780, LBP-4092, LBP-5194, LBP-0762, and LBP-0771) collected by field party personnel from these showings revealed up to 0.025% Cu, 0.04% Zn, and traces

TABLE 2. SUMMARY OF THE RESULTS OF RADIOMETRIC SURVEYS AND CHEMICAL ANALYSES, AND EXTENT OF DIAMOND DRILLING PROGRAMS IN THE CROSS LAKE AREA.

Property	Average radiometric anomalies X background	Narrow zones of high radiometric anomalies	U_3O_8/percent Surface Sampling Range	Surface Sampling Maximum	Drill Cores Sampling Range	Drill Cores Sampling Maximum	Number of diamond drill holes/m
AJM Explorations Limited (1)	east section: 2-5X	east section: 7.5-9X	-	-	-	-	62/2266.5
Canadian Arrow Mines Limited (3)	-	-	0.002-0.09	0.22-0.63	-	-	-
Consolidated Imperial Resources Limited (4)	3.5-7.5X	9-13X	.005-.065	0.39	0.007-0.019	0.036	5/657.5
Fyock and Associates (6)	2-3X	10X; 40X	bulk samples: 0.047; 0.12; 0.56	-	over small core lengths: 0.24; 0.006; 0.134	-	12/337
Groundstar Resources Limited (8)	-	-	0-.096	-	0.007-0.030	0.044-0.055	19/1006
D. Riddell (11)	-	-	0.006-0.110	0.350-0.514	0.005-0.032	0.040-0.051	5/138
Westwind Mines Limited (14)	1.25-3X	-	0-.014	-	-	-	8/564.5

(Assessment Files Research Office, Ontario Geological Survey, Toronto.)

of lead, gold, silver, and mercury (Geoscience Laboratories, Ontario Geological Survey, Toronto). Analytical data of samples from this stratigraphic unit are summarized in Table 4.

Minor zinc and lead mineralization, revealed by the geochemical surveys conducted by the Geological Survey of Canada (1977) and by St. Joseph Explorations Limited (Assessment Files Research Office, Ontario Geological Survey, Toronto) in the Little Green Lake area, are associated with the above stratiform sulphide mineralization.

Disseminated pyrite, accompanied by chalcopyrite and pyrrhotite, occurs also in the mafic to intermediate metavolcanic rocks (units 1a,c; 4a,b). Stringers and disseminations of pyrite, associated with pyrrhotite and chalcopyrite, form stratiform bands in the mafic to intermediate metavolcanics (units 1a,c) in the southeastern part of the map area. Estimated concentration of sulphides in these zones is about 2%. Several rusty weathered gossan zones, up to 1.5 m wide, were located within this unit north of the village of Coxvale and on the shore of Cross Lake (Narrows Point area). A grab sample (LBP-4201) from a gossan zone taken by field party personnel assayed 0.1% Cu and traces of nickel (Geoscience Laboratories, Ontario Geological Survey, Toronto). Copper (0.01%) and nickel (0.01%) were detected in the core sample (at 62 m depth) that was taken and assayed by Groundstar Resources Limited during their uranium exploration program (Assessment Files Research Office, Ontario Geological Survey, Toronto). This mineralization is considered by the author to be syngenetic.

MOLYBDENUM

Two occurrences of molybdenum mineralization have been identified in the northeastern part of the map area. The mineralization is in the form of molybdenite (MoS_2) and is found in white, medium grained pegmatite sills.

A molybdenite showing found in a farm field in the northeastern corner of the map area (Lot 22, Concession VIII, Palmerston Township) contains molybdenite patches 2 to 10 mm in diameter within a large quartz zone in a pegmatite. The outcrop has been blasted into large boulder-size fragments. A second, rather small occurrence is located in Lot 16, Concession VI, Palmerston Township. Small molybdenite flakes occur in a pegmatite sill hosted by narrow bands of metavolcanic rocks (unit 1c).

SILVER

Silver mineralization is generally sparse in the Ardoch Area occurring only as traces in the gold bearing associations.

TUNGSTEN

Numerous samples of marble collected by the field party in the map area were tested with ultraviolet light for presence of scheelite, with negative results. Two samples of marble collected by the author from the core (LBP-0241) and the southern limb (LBP-0161) of the Plevna Antiform assayed less than 500 ppm tungsten (Geoscience Laboratory, Ontario Geological Survey, Toronto).

IRON OXIDES

Small magnetite grains occur as an accessory in some layers of the felsic metasedimentary gneisses (unit 5b), some pegmatites, gabbro-dioritic rocks (unit 8a), and pelitic schists (unit 11a). A narrow (30 cm) layer of massive magnetite and pyroxene within marble probably resulted from contact metasomatism. This showing is located on Lot 24, Concession VI, Palmerston Township.

NONMETALLIC MINERALIZATION

MARBLE

Carbonate metasediments underlie large areas in the central and northeastern parts of the region and consist of a variety of different carbonate and calc-silicate assemblages.

Marble exposed in the cores of the Plevna Synform and Antiform, and in a northeasterly trending band northeast of the Fernleigh Syncline, is in many places contaminated with abundant lenses and layers of quartzite, and interlayered with clastic siliceous and calc-silicate metasediments. Nevertheless, there are several locations where pure calcitic marble (unit 6b) and dolomitic marble (unit 6a) occur in appreciable quantities as shown on the accompanying geological map (back pocket).

A band of dolomitic marble (unit 6a) interlayered with calcitic marble (unit 6b), extending from the Plevna Fault to the northeast along the sides of Highway 506 to and beyond Cards Lake, might also be of economic potential on account of its width, (about 500 m), lateral extent (about 5 km), and easy access.

Two abandoned marble quarries are found in the western part of this band. The quarries, set about 150 m apart, were operated in 15-20 m high cliffs, about 100 m north of Highway 506. White, medium grained marble, contaminated with coarse grained calc-silicate aggregates, is exposed in the walls. Back walls of the quarries lie near the contact with the footwall comprised of clastic siliceous metasediments and felsic metavolcanics.

The Breen showing, in Lot 38, Concession IV, Clarendon Township, is a marble showing located about 1.2 km east of the marble quarries. It was sampled by Vos and Storey (1979) and returned the following chemical analyses: Sample PM139—SiO_2 2.36%, Al_2O_3 0.7%, Fe_2O_3 0.8%, MgO 20.0%, CaO 29.2%, LOI 46%, CaO:MgO = 1.46:1, acid insolubles 3.30%. Sample PM140—SiO_2 1.81%, Al_2O_3 0.4%, Fe_2O_3 0.4%, MgO 20.4%, CaO 28.9%, LOI 46.5%, CaO:MgO = 1.41:1, acid insolubles 2.06%.

The Bremmer showing is located in the east portion of Lot 31, southwest range of Clarendon Township. Two partial chemical analyses were performed on two samples from this area: Sample PM141—SiO_2 8.23%, Al_2O_3 1.8%, MgO 10.1%, Fe_2O_3 0.7%, CaO 27.5%, LOI 39.8%, CaO:MgO = 2.75:1, acid insolubles 10.7%. Sample PM142—SiO_2 8.0%, Al_2O_3 2.4%, MgO 1.6%, CaO 46.6%, LOI 40.0%, CaO:MgO = 29.12:1, acid insolubles 11.6% (Geoscience Laboratories, Ontario Geological Survey, Toronto).

MICA

Some mica, mainly muscovite, was extracted many years ago from a trench on the farm of Fred Maly in Lot 24, Concession II, Palmerston Township (de Schmid 1912). The mica-bearing pegmatite is exposed on the surface and in the old workings for a distance of about 60 m along the northern contact of the muscovite schist of the Bishop Corners Formation. The pegmatite dike is about 0.60 to 0.90 m wide. In places, pockets of muscovite up to 10 cm in diameter, but with numerous inclusions, have been reported from this showing (Smith 1956).

QUARTZ AND FELDSPAR

Pegmatite dikes and sills form a prominent part of the outcrop in the southeastern and the northwestern parts of the map area. Most of the white and pink pegmatite phases are relatively fine grained. Very coarse grained pegmatites of larger dimensions, favoured for feldspar extraction, are seldom found. Little attempt has been made to exploit pegmatites for their silica content.

TREMOLITE

Tremolite occurs in abundance in many places throughout the marble and dolomitic marble unit (6c) north of the Fernleigh Syncline. Quartzite layers, often contorted and broken into lenses and nodules, are frequently interbedded in the marble. Some of the tremolite has been formed by reaction between quartz and carbonate, and occurs as a reaction rim at the carbonate-quartzite contacts. Larger accumulations of tremolite are found in the hinge of the Plevna Antiform and on the eastern and western sides of the Plevna Fault where it underlies the marble core of the Plevna Synform.

KYANITE

The occurrence of kyanite on Lot 26, Concession X, Clarendon Township was first reported by W. Miller and C. Knight in 1913. B.L. Smith (1951) describes the occurrence as follows:

> "In the central part of Clarendon Township near Fernleigh, the schist contains, in places, considerable kyanite along with sillimanite and staurolite. The Fernleigh portion of the band is considered worthy of attention, having regard to the possibility of locating a commercial deposit of kyanite. The kyanite occurs in elongated crystals up to 8 inches in greatest dimension."

These crystals occur in a fine grained, sheared sericite-sillimanite-quartz schist. The distribution of kyanite in the schist band, which is itself about 90 m wide, is irregular. One band was 9 m wide and, in addition to the log-like kyanite crystals, it contained aggregates of radiating kyanite blades up to 1 inch long. The best grade of material may run 10-20% kyanite over a 9 m width. Some of the kyanite is dark grey to black in colour on fresh surfaces (Ontario Department of Mines, Industrial Mineral Report No. 4, 1952, p.6).

Kyanite and staurolite occur in a narrow band in the pelitic (muscovite-biotite-garnet) schist of the Bishop Corners Formation exposed on the northern limb of the Fernleigh Syncline, anywhere from the western boundaries of the map area to the Ardoch Road and Highway 506 junction.

One of the best and most accessible exposures is located on the power line clearing about 400 m northeast of the village of Fernleigh. Kyanite occurs as blue to blue-grey, bladed, unoriented crystals up to 10 cm long, or as radiating aggregates of smaller crystals. Dark brown single staurolite crystals up to 5 cm long, or penentration twins of staurolite, accompany kyanite in some locations.

Northeast of the Ardoch Road-Highway 506 junction, the assemblage kyanite-staurolite-garnet-biotite-muscovite prograde into the assemblage sillimanite-garnet-biotite-muscovite.

DESCRIPTION OF PROPERTIES AND OCCURRENCES

The history of exploration given in this report does not extend beyond December, 1980 and is limited to company reports available to the public and to data obtained by field party personnel during mapping.

AJM EXPLORATIONS LIMITED (1)

Lot 1, Concession III; Lots 2, 3, 4, Concessions II, III, IV, V; Lot 5, Concessions II, III, V; Palmerston Township

The property occupies about 19 km^2 and extends east from the southern arm of Cross Lake to beyond the eastern boundary of the map area. The bedrock comprises the Northbrook Batholith and several northeast trending bands of metavolcanic rocks, marble, and metaconglomerate, which are host to numerous uraniferous pegmatite dikes and sills.

The first recorded work on the property was undertaken by J. and H. Eastmen, D. Riddel, and a Mr. Harvey in 1956 and 1957. To examine the extent of uranium mineralization at depth, they sank 18 diamond-drill holes (totalling 584 m) in the

TABLE 3. SUMMARY OF THE EXPLORATION PROGRAMS CARRIED OUT ON THE AJM EXPLORATIONS LIMITED PROPERTY (1) BETWEEN 1968 AND 1977.

Keevil Mining Corporation Limited. 1968-1969. West Part	Bijou Mines *Limited*. 1977. Central Part	Rexdale Mines *Limited*. 1968-1969. East Part	Geophysical *Engineering*. Palmerstone. 1976. East Part
Airborne radiometric survey	Ground radiometric survey and one diamond drill hole	Ground radiometric survey and 32 diamond drill holes	Airborne radiometric and magnetic survey and 11 diamond drill holes
(under the Substantial Development Limited Option	(74 m)	(1215 m)	(393 m)

(Assessment Files Research Offices, Ontario Geological Survey, Toronto.)

TABLE 4. ASSAYS OF SAMPLES FROM A STRATIGRAPHIC UNIT EXPOSED BETWEEN THE PLEVNA SYNFORM AND THE FERNLEIGH SYNCLINE.

Sample Number	Rock Type	Gold ppb	Silver ppm	Copper ppm	Lead ppm	Zinc ppm	Mercury ppb
LBP-0762	marble	7	-	13	<10	29	160
LBP-0760	marble	-	-	-	<10	72	<20
LBP-0771	marble	18	-	250	22	400	110
LBP-0786	hornblende-biotite gneiss	-	-	142	-	-	-
LBP-4092	marble	8	-	123	16	19	-
LBP-5194	marble	40	<2	157	-	-	-

(Geosciences Laboratories, Ontario Geological Survey, Toronto.)

eastern part of the area. Various parts of this large property have been staked and examined since then (*see* Table 3).

Radiometric surveys delineated a large number of radiometric anomalies ranging from two to eight times background throughout the area with some high local concentrations (13 times background). Many radiometric anomalies showed a trend parallel to the regional strike (025°) of the host rock. Most prospective areas were further explored by diamond drilling, but no analytical data from diamond-drill holes were reported.

In 1969, Rexdale Mines trenched samples and diamond-drilled 44 holes (totalling 5154 feet) to test the four major radioactive zones which were located by an earlier scintillometer survey.

Many random samples taken from trenches gave assays of about 0.20% U_3O_8 and grab samples assayed as high as 2.68% U_3O_8 (The Northern Miner Press, March 20, 1969).

Channel samples from one trench returned an average of 0.07% U_3O_8 over 40 feet, another trench in the same zone gave 0.10% U_3O_8 across 10 feet (The Northern Miner Press, February 27, 1969).

In the southeastern part of the property, radioactivity was noted over a width of 20 to 30 feet and for a length of 600 feet. Assays are reported as high as 0.18% U_3O_8. Radioactivity was also reported in a central location on the claims over a width of up to 150 feet and for a length of 2400 feet. Grab samples are reported to

have assayed 0.06, 0.09, and 0.25% U_3O_8. On the northern side, radioactivity was noted for a length of 600 feet and a grab sample assayed 1.02% U_3O_8.

Results of the drilling on the "A", "B", "F", and "G" zones were reported encouraging. In hole A-1, an intersection of 38 feet averaged 1.82 lbs U_3O_8 per ton. Other intersections included one of 35.3 feet in hole A-2, averaging 1.52 lbs U_3O_8 per ton, and 15 feet in hole A-3 averaging 1.40 lbs U_3O_8/ton. In the "F" zone, located southeast of "A" zone, values as high as 3.50 lbs U_3O_8per ton across 12.5 feet were obtained. Good assays across significant widths were also obtained in the "F" and "G" zones.

In 1979, AJM Explorations Limited carried out airborne radiometric and magnetic surveys on 63 contiguous claims. The survey detected a large number of top priority uranium prospects within the area and the company started a diamond drilling program in 1980 in the southeastern part of the property where the first diamond-drill holes were sunk by the early prospectors in 1956 (Assessment Files Research Office, Ontario Geological Survey, Toronto). A sample (LB5-1025) from a pegmatite sill collected by the author in the central part of the property (showing field scintillometer readings of eight times background) assayed 0.024% U_3O_8 and 0.005% ThO_2 (Geoscience Laboratories, Ontario Geological Survey, Toronto).

BOERTH MINE (2)

Lot 29, Concession VIII, Clarendon Township (Patented mining and surface rights: B.C. Robson)

The gold mine initially owned by the Boerth Mining Company of Ontario started operation in the 1890s (De Kalb 1900). The ore was said to have been extracted mainly by surface stripping and open cutwork on crosscutting tourmaline-arsenopyrite-quartz veins. C. De Kalb (1900) describes the main shaft as being 36.5 m deep, inclined 65° to the southwest and open at the 22.8 m level by 16 m of north-south trending drift. A second shaft, located 160 feet to the south, was sunk to a depth of 35 feet. The mine was equipped with a 10 stamp mill and power plant. The mine became unprofitable to operate and went out of production by 1904 (Armstrong 1976). Operations were suspended in the fall of 1899 and the property was subsequently acquired by the Clarendon Mining Company of Ontario Limited. Work resumed for a few months in the fall of 1901 and some work was also done in 1903 and 1908. In 1915, it is reported that the mill was torn down and the equipment sold for scrap. In 1900, 13 ounces of gold was produced from an unknown amount of ore (Gordon *et al.* 1979, p.34).

The only exploration on record is a diamond drilling program carried out in 1952 by Bruce Robson (Assessment Files Research Office, Ontario Geological Survey, Toronto). Three diamond-drill holes, totalling 166.6 m, were completed on the property (No. 1, dip 62°/71.9 m; No. 2, dip 40°/67.3m; No. 3, dip 55°/27.4 m).

The host rocks intercepted by the drillholes are described as silicified biotite schist and wacke containing sparse to good mineralization of pyrite, pyrrhotite, arsenopyrite, and tourmaline, mainly in the neighbourhood of the quartz-tourmaline veinlets. Only a few narrow sections of marble were cut by the drilling. Narrow zones of quartz-tourmaline veinlets were intercepted at depths between 11.5 and 183 feet (3.4 and 55.0 m) (*see* Table 5).

The best zone was intercepted by drillhole No. 1 and showed the following sequence:

1. 82.8 to 83.8 feet (24.84 to 25.14 m): quartz-tourmaline vein with an assayed gold value of $40.95 per ton (1952).
2. 83.8 to 85.2 feet (25.14 to 25.56 m): sheared greywacke with tourmaline, with an assayed gold value of $3.15 per ton (1952).
3. 85.2 to 86.5 feet (25.56 to 25.95 m): quartz-tourmaline vein with an assayed gold value of $35.0 per ton (1952).

Some assayed core sections described as silicified and/or sheared wacke, with or without tourmaline, yielded gold values of $0.17 to $1.40/ton (1952) (Assessment Files Research Office, Ontario Geological Survey, Toronto).

TABLE 5. ASSAYS OF CORE SECTIONS OF QUARTZ-TOURMALINE BEARING VEINLETS FROM THE BOERTH MINE (2).

Drill Hole No.1	Gold, $/ton (1952)	Drill Hole No.2	Gold, $/ton (1952)	Drill Hole No.3	Gold, $/ton (1952)
44.0-44.2 ft	0	34.5-34.7 ft	N.A.	11.5-11.6 ft	N.A.
82.8-83.8	$40.95	53.8-54.2	$13.65	21.3-22.3	N.A.
85.2-86.5	$35.0	102.8-103.2	N.A.	30.0-32.0	$0.17
183.0-184.0	$ 9.10	156.9-158.3	$ 5.25	68.0-70.0	$19.60

(Assessment Files Research Office, Ontario Geological Survey, Toronto.)

In August 1963, the property was optioned to New Providence Investments Limited and later in the same year this option was assigned to Ganda Silver Mines Limited. To the end of May 1964, 47 holes, totalling 7054 feet, had been diamond-drilled by Ganda Silver Mines Limited. Ganda Silver Mines Limited also took 16 samples from seven different quartz veins, up to 3 feet in width. All of these, except one chip sample, were channel samples. One chip sample assayed 2.32 ounces of gold per ton and the remaining samples averaged 0.67 ounces of gold per ton (Department of Energy, Mines and Resources; Ottawa, Mineral Policy Section, National Mineral Inventory File AU1). A series of marble (units 6a, 6b, 6c) and infolded metasedimentary biotite gneiss (unit 7b) underlie the area of the mine.

The main shaft is situated in a clearing about 230 m south of the power line (see accompanying map). The shaft is flooded and only the top 2 m of the shaft opening are exposed. Dark biotite gneiss and remnants of the quartz vein are seen in the shaft walls. The bedrock immediately around the shaft consists of marble, indicating that the shaft was sunk near the contact of the narrow band of biotite gneiss with marble. The rocks on the property strike at N60°E and dip steeply to the northwest. The ill defined remnants of the quartz vein in the shaft opening preclude accurate measurement of the vein orientation; however, from the direction of the drifts (De Kalb 1900), it can be implied that the quartz vein had an approximately north-south trend. Smith (1956) writes that most of the mining was by open cut on certain quartz veins that cut diagonally across the gneiss at an angle of 45° to 60° to the right of the strike of the gneisses. Material in the ore dump consists mainly of dark biotite gneiss and quartz. Quartz chips carry tourmaline and minute disseminated grains of arsenopyrite and chalcopyrite. A sample collected by the author in the ore dump yielded 18.9 ppm gold, 0.04% arsenic, and only traces of copper (Geoscience Laboratories, Ontario Geological Survey, Toronto). A flooded pit, open in the marble near the contact with the biotite gneiss, was found about 500 m to the southeast of the main shaft. Quartz vein samples collected by the field party from around this pit were mineralized with small stringers of chalcopyrite and pyrite, and assayed 0.5% copper, 1270 ppb gold, 75 ppm silver, and traces of arsenic (Geoscience Laboratories, Ontario Geological Survey, Toronto).

CANADIAN ARROW MINES LIMITED (3)

Lots 16 and 17, Concessions V, VI, Clarendon Township

In 1969, Canadian Golden Arrow Mines Limited (formerly Consolidated Golden Arrow Mines Limited) conducted radiometric and magnetic surveys on eight claims west and north of Pine (Coxvale) Lake. Later, a program of plugger hole sampling was carried out in order to examine several uranium showings located on the property.

Pegmatite samples assayed 0.002 to 0.009% U_3O_8 and samples collected from highly anomalous radioactive zones assayed 0.02 to 0.68% of U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The rocks underlying the area comprise grey pegmatite dikes and red and white pegmatite dikes and gneiss of the Northbrook Batholith. The location of pegmatites carrying good radiometrics is near or along the anticlinal axis which passes through the southwest arm of Pine (Coxvale) Lake (Assessment Files Research Office, Ontario Geological Survey, Toronto).

CONSOLIDATED IMPERIAL RESOURCES LIMITED (4)

Lots 10, 11, Concession VI; East 1/2 Lots 10, 11, Concession V; West 1/2 Lot 11, Concession VII; Palmerston Township

The property is situated south and east of Cranberry Lake and covers approximately 4.5 km^2. Almost half of the property lies beyond the eastern boundary of the map area. Between 1975 and 1977, extensive exploration focussing on the uranium-bearing pegmatite dikes and sills was carried out on the property.

In 1975, L. Golant initiated the exploration in this area by conducting a ground radiometric survey. In 1975, 51 blast holes were drilled with a Cobra® rock drill and a scintillometer survey was done by Consolidated Minerals Company Limited. In 1976, Consolidated Imperial Resources Limited acquired the right to explore the property and carried out a radiometric survey and sampling. Their report indicates that the survey successfully delineated several zones of high radioactivity. Pegmatite dikes 0.60 to 1.20 m wide and few conformable pegmatites 30 to 60 m wide, and continuous along strike up to 365 m, were located on the property. The best assays of 15 to 25 pound bulk samples yielded 1.00 pound of U_3O_8 and 0.30 pounds of ThO_2 per ton. The original grab sample from anomaly "A" ran 6.0 pounds U_3O_8 and 1.5 pounds ThO_2 per ton. Diamond-drill core assays varied from .001 to 0.30 pounds U_3O_8 per ton. The analyzed grab samples yielded from 0.10 to 1.30 lbs/ton of U_3O_8 and from traces to 0.60 lbs/ton of ThO_2. Surface exploration has indicated a strike length of some 1800 feet of mineralization (The Northern Miner Press, October 21, 1976). In 1977, Noranda Explorations Limited, under the Consolidated Imperial Resources Limited option, carried out a radiometric survey and a diamond drilling program. Arcuate shaped anomalies averaging 3.5 to 4.7 times background, with local spots showing 10 times background, were located southwest of Cranberry Lake. On the northeastern shore of Cranberry Lake, pegmatite dikes carried radiometric anomalies 7.5 times background. On the southeast shore of Cranberry Lake, a northeast trending linear zone with spotty anomalies up to 9 times background was discovered. The eastern part of the property displayed anomalies of irregular shape averaging 5 to 6 times background and local concentrations up to 13 times background were encountered.

Analyzed pegmatite samples yielded 0.50 to 0.70 pounds of U_3O_8 per ton and one sample collected from the highly anomalous radioactive zone northeast of Cranberry Lake revealed 7.80 pounds U_3O_8 per ton (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Five diamond-drill holes (totalling 664 m) were sunk east and southwest of Cranberry Lake. Assayed core samples revealed 0.007 to 0.036% of U_3O_8 and 0.03 to 0.05% of ThO_2. A report on the diamond drilling indicates that no significant uranium mineralization was discovered at depth (Assessment Files Research Office, Ontario Geological Survey, Toronto).

COOK PROPERTY (5)

Lot 23, Concession IX, Clarendon Township

The Cook property is located 200 m west of the gravel road that runs in a north-south direction from Swaugers Lake to the Mississippi River. A few outcrops of amphibolite (metamorphosed mafic calcareous tuffs, units 3c,d) are present in a float overburden field. The bedrock, penetrated with irregular quartz stringers, is exposed in a 5 m deep pit.

Wells (1902, p.105) describes the property as follows:

"A shaft has been sunk forty feet by J.W. Cook, Marmora, and stripping done on the surface. The ore on the dump shows mispickel [arsenopyrite] mixed

with quartz and schistose diorite, the latter being the country rock. There is no well defined vein on the property".

Ore assays varied between 0.19 and 0.87 ounces of gold per ton and an average of 14% arsenic (Assessment Files Research Office, Ontario Geological Survey, Toronto). Dump samples consist of amphibolite penetrated with the irregular quartz stringers. Arsenopyrite is concentrated in patches up to 1.5 cm in diameter. A dump sample collected by the author yielded 3.00% of arsenic and traces of gold, copper, and silver (Geoscience Laboratories, Ontario Geological Survey, Toronto).

FYOCK AND ASSOCIATES (6)

East 1/2 Lot 14, Concession IV; West 1/2 Lot 15, Concession V; Lot 15 Concession IV; Lots 16, 17, Concessions II, III, IV; Lot 18, Concessions II, III; Clarendon Township

This property, about 3 km^2 in extent, is located between Pine Lake and Fawn Lake and is underlain by gneiss of the Northbrook Batholith. In 1968 and 1969, Fyock and Associates conducted a comprehensive exploration program of geological mapping, magnetic and radiometric surveys, trenching, and diamond drilling on 20 claims.

Pegmatites of three modes were encountered on the property: 5 to 30 cm wide pegmatite sills; 30 to 120 cm wide pegmatite dikes striking 90° to 120° and paralleling the system of joints; and a few large pegmatites of no common directional pattern.

The radiometric anomalies averaged two to three times background with the occasional small area (1 m in diameter) showing anomalies between 10 and 40 times background. Grab samples that were taken from the highly anomalous radioactive zones yielded 0.005 to 0.007% of U_3O_8 and 0.0% ThO_2.

Three bulk samples of 10 to 15 pounds, blasted from the best uraniferous pegmatite showings on the property, assayed 0.120%, 0.056%, and 0.047% of U_3O_8. Highly anomalous radioactive pegmatite zones were further examined by 12 closely spaced (7.60 m apart) diamond-drill holes (totalling 337 m). The best assays revealed 0.74%, 0.24% and 0.006% of U_3O_8 over narrow core lengths of 0.27 to 0.82 m. The best sample over a width was 0.02% U_3O_8 over 2.4 feet and the best diamond-drill sample was 0.134% U_3O_8 over 15 feet. About 25 pounds of rock blasted from the surface at this location assayed 0.56% U_3O_8. The report on diamond drilling indicates that none of the pegmatites widened up or continued in width with economic grade at depth (Assessment Files Research Office, Ontario Geological Survey, Toronto).

GANDA SILVER MINES LIMITED (7)

East half, Lot 27, Concession IX; Clarendon Township

A small occurrence of lead south of Swaugers Lake is mentioned by Hewitt (1964). There is a shallow pit along the southern side of the road leading to the farmhouse on the southern shore of Swaugers Lake. A stratabound quartz vein, 0.50 m wide and steeply dipping (N62°E, dip 75° to the northwest), is well exposed in the northeastern corner of the pit. It is hosted by a dolomitic marble (unit 12b) of the Myer Cave Formation near the contact with pelitic schist (unit 11a) of the Bishop Corners Formation. No macroscopic mineralization on the outcropping quartz vein is visible. A thorough examination of the small dump revealed only one speck of galena. Diamond drilling carried out by Stratmat Limited in 1953, and by Ganda Silver Mines Limited in 1964, failed to intercept any quartz veins and/or mineralization (Assessment Files Research Office, Ontario Geological Survey, Toronto).

GROUNDSTAR RESOURCES LIMITED (8)

West 1/2 Lot 6, Concession IV; Lot 7, Concession IV, and V; Lot 8, Concession IV; west 1/2 Lot 8, Concession V; Lot 9, Concession IV; Lot 10, Concession IV; west 1/2 Lot 10, Concession V; Palmerston Township

This large parcel is comprised of 65 claims: 28 claims lie within the map area and the remaining 37 claims lie outside the map area.

In 1976, Grange Mining Corporation Limited conducted an airborne radiometric and magnetic survey on 73 claims between Lots 6 to 11, Concessions IV to VIII, Palmerston Township with the exclusion of the Cranberry Lake area (Lots 10, 11, Concession VI; east 1/2 Lot 11, Concession V; west 1/2 Lot 11, Concession VIII) (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The report on the radiometric survey indicated that some radiometric anomalies warranted ground investigation. Between 1976 and 1978, Groundstar Resources Limited carried out a comprehensive exploration program of detailed geological mapping (scale 1:2400 or 1 inch to 200 feet), trenching, and diamond drilling.

Based on the results of the eight relatively shallow drillholes, plus rather extensive surface trenching, a very large tonnage of low grade material (on the order of 0.25 lbs U_3O_8 per ton) with open pit potential is indicated (The Northern Miner Press, January 20, 1977).

Exploration revealed two bands of radioactive pegmatite bearing altered sediments. The most northerly is exposed in scattered outcrops across a width of 800 feet and along strike for 3000 feet, while the second, which lies immediately to the south, has been exposed across widths of 1500 feet and traced for a strike length of 7000 feet. A consulting geologist estimated that the radioactive pegmatites make up 50% of the rock mass in those two bands. Bulk samples taken from rock trenches within the area underlain by the radioactive pegmatites showed a U_3O_8 content varying up to 1.92 pounds with the average in the range of 0.50 pounds per ton. The first seven holes of the drilling program were put down in the area of surface trenching and covered a strike length of 400 feet. All cut radioactive pegmatite, with assay returns showing U_3O_8 contents in an average range of 0.25 to 0.50 pounds per ton, but also as high as 1.1 pounds per ton (The Northern Miner Press, January 20, 1977).

The central part of the property, situated just along the eastern limits of the map area, is underlain by metavolcanics (units 1a, 1c). Radioactive pegmatite sills are estimated to make up about 50% of the outcrop within the metavolcanics. The size of the pegmatites averages 7.50 to 15.0 m in width and 61 m in length. A few very large pegmatites (60x183 m) were locally encountered. Assayed pegmatite samples revealed from traces to 1.92 pounds U_3O_8 per ton, and two analyzed bulk samples yielded 0.002% U_3O_8 and 0.50 pounds U_3O_8 per ton respectively (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Thirteen diamond-drill holes totalling 703 m were sunk in the central most promising part of the property and six diamond-drill holes (311 m) were drilled on claim 460277 outside of the map area.

The best assays obtained from the drill cores revealed 0.045% to 0.055% of U_3O_8, others averaged from 0.002 to 0.030% of U_3O_8. The report on diamond drilling indicates that no significant uranium rich zones were cut by the diamond drill holes (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The eastern part of the property, adjacent to Big Black Bay, is underlain by the Northbrook Batholith and radioactive pegmatite dikes, swarms, and sills are less frequent in this area. Consequently, 25 claims in this area were cancelled in 1980 (southeast 1/4 Lot 6, Concession III; west half Lot 6, Concession IV; Lots 7, 8, 9, 10, Concession IV; east 1/2 Lot 10, Concession V; east 1/2 Lot 7, 8, Concession VI).

C. KEHOE (9)

Lot 28, Concession X; Lot 29, Concessions IX, X; Lot 30, Concessions VIII, IX; east 1/2 Lot 31, Concession X; Lot 31, Concession IX; west 1/2 Lot 31, Concession VIII; Clarendon Township

A large part of the property is situated between the power line and Swamp Creek, and in the south, immediately adjacent to the Boerth Mine (2) and the Webber property (13).

Four claims are located north of Swamp Creek. The underlying bedrock comprises marble (units 6a, 6c) and quartzo-feldspathic biotite gneiss (unit 7b). Quartz stringers and narrow (10 to 20 cm) irregular quartz veins with the occasional rusty stain are erratically distributed on the property. A grab sample of the veined quartz, collected by the field party at the eastern end of the property, contained traces of gold and copper (Geoscience Laboratories, Ontario Geological Survey, Toronto).

RAM PETROLEUMS LIMITED (10)

Northeast 1/4 Lot 6, Concession V; Lot 6, Concession VI; southwest 1/4 Lot 7, Concession VI; Palmerston Township

The largest part of this property lies outside the eastern limits of the map area, where a talc-tremolite deposit is currently being extracted and processed by Ram Petroleums Limited. The tremolite products will be used as additives for asphalt road construction.

Exploration activities in this area were concentrated on the delineation and evaluation of the tremolite-talc deposit enclosed by marble and metavolcanics. Examination of this deposit was not included in the present survey. A small part of the property that lies within the map area is underlain by metavolcanics that host numerous uraniferous pegmatite sills and dikes.

D. RIDDELL (11)

East 1/2 Lot 6, Concession IV; west 1/2 and northeast 1/4 Lot 6, Concession V; Palmerston Township

The five contiguous claims of the property are located east of Little Black Bay. Reconnaissance, and ground and airborne radiometric surveys were carried out by B. Reid, D. Riddell, and Mr. Bigwood between 1975-1977. A variety of radiometric anomalies, most of them conformable with the strike of the underlying metavolcanics (units 1a, 1c) and metasediments (unit 6) were located in the area (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In 1977, Conorex Development Limited conducted geological and radiometric surveys and sunk five diamond-drill holes totalling 452.0 feet to test uranium mineralization at depth. The assayed surface samples revealed from 0.005% to 0.514% of U_3O_8, while assayed core samples showed lower values of U_3O_8 ranging from 0.005 to 0.051%. The average drill core assay was 0.017% U_3O_8 over 4 feet. The highest core assay was 0.051% U_3O_8 over 1.5 feet. The report indicates that no economic concentration of uranium mineralization was cut by drilling (Assessment Files Research Office, Ontario Geological Survey, Toronto).

SELCO MINING CORPORATION LIMITED (JAMES MINE) (12)

Lot 32, Concession IV; Lot 33, Concessions II, IV, V; Lot 34, Concessions II, III; Clarendon Township

The property consists of 12 claims and is located along the power line, about 2.8 km northeast of Ardoch village. At the western end of the property, two pits are present in the clearing directly below the power line. One pit is about 3 m deep, the second pit, located 50 m to the east, is flooded and probably deeper. According to Smith (1956) and Armstrong (1976), this should be the site of the James Mine. Both pits are underlain by dolomitic marble. A quartz vein exposed in the accessible pit is about 0.70 m wide and parallels the strike of the country rock. It is mineralized with stringers and small clusters of chalcopyrite, and patches of malachite. A chalcopyrite-bearing quartz sample (LBP-0430) collected by the author from the ore dump contained 13.0 ppm gold, 102 ppm silver, 0.59% copper, and traces of lead (Geoscience Laboratories, Ontario Geological Survey, Toronto).

The property is underlain by marble (units 6a, 6c) interbedded with narrow bands of biotite-quartzo-feldspathic gneiss (units 5b, 7b). Other quartz veins, up to 80 cm wide, pinch and swell out along strike, quartz stringers are erratically distributed on the property, and the mineralization appears to be widely scattered. An assayed sample of the quartz vein, collected by the field party 55 m southeast of the pit, revealed only traces of gold and copper (Geoscience Laboratories, Ontario Geological Survey, Toronto).

In 1979, St. Joseph Explorations Limited carried out geological and geochemical surveys on all 12 claims. Moderate Pb-Zn anomalies were delineated and weak sphalerite-pyrite mineralization was described in the area of Little Green Lake. Weak Cu-Pb-Zn anomalies were also revealed in the area of James Lake and north of Little Green Lake. The presence of gold in the chalcopyrite-bearing quartz veins was also reported (Assessment Files Research Office, Ontario Geological Survey, Toronto).

A crosscutting trench about 60 m long located about 200 m east of Little Green Lake exposes marble with narrow bands of quartzo-feldspathic metasedimentary gneiss and a few narrow concordant quartz veins. A sample (LBP-0762) of marble taken by field party personnel at this location yielded 13 ppm copper, <10 ppm lead, 29 ppm zinc, 7 ppb gold, and 160 ppb mercury. A second crosscutting trench, located about 1000 m east of Little Green Lake and about 300 m east of the eastern boundary of the property, exposes the same stratigraphic horizon of marble and intercalated quartzo-feldspathic metasediments. A sample of marble (LBP-0771) collected by the author from this showing revealed 0.025% copper, 0.04% zinc, 0.015% barium, 18 ppb gold, and 110 ppb mercury (Geoscience Laboratories, Ontario Geological Survey, Toronto).

SELCO MINING CORPORATION LIMITED (WEBBER PROPERTY) (13)

East 1/2 Lot 28, Concession IX; Clarendon Township

A shaft and about 150 m of trenching, 200 m northeast of Swaugers Lake, were first described and referred to as the Webber property by Smith (1956). Trenching parallels the strike (N65°E) of the steeply dipping (80° northwest) bedrock, and exposes remnants of the conformable quartz vein hosted by quartzo-feldspathic biotite-carbonate bearing gneiss. Minor arsenopyrite and good values of gold were reported. The northeastern side of the trench terminates in a 10 m deep pit. In 1963, Ganda Silver Mines Limited sunk five diamond-drill holes in the immediate vicinity of the original openings. Limy gneiss and marble, containing quartz patches and injections with disseminated sulphide and arsenopyrite, were intercepted by the drillholes at anywhere from 5.50 to 35 m depths. Analyzed core samples revealed traces of gold (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Other quartz veinlets and lenses (up to 30 cm wide), both conformable and disconcordant, were located on the property. No macroscopically observable sulphide mineralization, except rusty weathered patches were visible. Samples collected by field party personnel yielded only traces of gold, copper, and arsenic (Geoscience Laboratories, Ontario Geological Survey, Toronto). Minute disseminated grains of arsenopyrite in quartz and gneiss are rarely seen in the ore dump.

WESTWIND MINES LIMITED (14)

Lots 8,9, Concessions II, III; Lot 10, Concession III; Palmerston Township

In 1976, D. Riddell carried out airborne radiometric and magnetic surveys on 18 contiguous claims between The Narrows and Big Black Bay in the Cross Lake area. In 1977, Westwind Mines Limited acquired the property and conducted a soil radon gas survey and a geological survey, followed by a diamond drilling program and surface work. Radiometric anomalies averaged 1.25 to 3 times background and displayed northeasterly and eastwesterly trends. Several pits, trenches, and eight diamond drillholes (totalling 610 m) were sunk in the eastern section of the property (Lot 9, Concession III). Assayed samples yielded from 0.0 to 2.8 pounds per ton of U_3O_8 in an erratic distribution (Assessment Files Research Office, Ontario

Geological Survey, Toronto). The larger part of the property is underlain by the "Cross Lake trondhjemite gneiss" (unit 9a). A narrow band of metavolcanic rocks (units 1c, 2c) stretches northeasterly (N60°E) from The Narrows to Kings Lake. Uraniferous pegmatite dikes and sills, showing field scintillometer readings up to four times background, are hosted by both gneisses and metavolcanic rocks. Pegmatites hosted by gneisses either parallel the system of the joints in the gneisses or cut irregularly through the gneisses, showing no common directional pattern. Pegmatite sills are hosted mostly by metavolcanics. A small anticlinal structure, with gneisses in the core and enveloped by metavolcanics, is exposed on the shore in the southeastern part of the property. Metavolcanics on the southern limb are practically interlayered with 0.30 to 0.60 m wide pegmatite sills carrying radiometric anomalies 2 to 4 times background.

N. WILSON (15)

Lot 29, Concession V; Clarendon Township

The northwest trending fault zone separates two parts of the property. The lower, western side is partly covered by swampy overburden; the elevated eastern side is underlain by marble (unit 6) and quartzo-feldspathic biotite gneiss (unit 7b). Sporadic occurrences of pyrite disseminated in biotite gneiss were seen in the field. The property was staked during the current survey and no exploration activities were reported.

SUGGESTIONS FOR FUTURE MINERAL EXPLORATION

The present study of the Ardoch Area shows that the known mineralization can be related to the stratigraphy and to the complex metamorphic, plutonic and deformational history of the area and provides basic data for the planning and execution of future exploration work. Major conclusions concerning the mineral potential of the area are summarized below.

METALLIC MINERAL OCCURRENCES

The occurrence of gold and base metal bearing quartz veins in the older stratigraphic units that lie at or near the contacts with the Flinton Group metasediments suggests that these zones may be of importance for gold and base metals mineralization.

The carbonate metasediments of the Myer Cave Formation host stratabound galena and zinc bearing quartz-dolomite veins within the map area, and other occurrences of zinc, lead, copper, and sulphosalts (Moore and Morton 1980) have been found in this unit west of the map area. Soil geochemical surveys and detailed geological mapping may be the best tools for the initial prospecting of this stratigraphic horizon (units 12a, 12b). This unit decreases in width northeast of the Ardoch Road and Highway 506 junction.

The mafic and the intermediate metavolcanic rocks (units 1a, 1c) occurring in the southeast part of the map area may be considered as possible exploration targets for copper mineralization. Small disseminations of pyrite, pyrrhotite, and chalcopyrite, and several gossan zones (marked "lim" on the map) were encountered within these units during the present survey. The fact that similar volcanic sequences yielded important copper deposits in the older greenstone belts should not be overlooked. Geological mapping, and geophysical and geochemical exploration techniques could be applied in this area.

Molybdenum mineralization is invariably found in the late pegmatite phases occurring in the metavolcanics near the hinge of the Cross Lake Antiform in the northeastern part of the map area.

Uranium mineralization is associated with pink and white pegmatite dikes and sills occurring in the Northbrook Batholith, and metavolcanics in the southeastern part of the map area, and in the Abinger granitic pluton in the northwestern part of the map area. The available data on the mineral exploration of the uranium deposits in the Cross Lake area indicate that the uranium mineralization tends to concentrate in spots, and that the best uranium mineral potential may lie in narrow zones of high grade mineralization. The larger tonnages of low grade appear to be less attractive at the current level of uranium prices. Although any pegmatite may show considerable radiometric anomalies, the best exploration targets appear to be pegmatite sills occurring within the metavolcanic rocks and along the border zones of the plutonic complexes. Their frequency of occurrence, large dimensions, and regular shape could host larger quantities of radioactive material. Also, the other zones of weakness, within the above described complexes, such as fault and shear zones, should be considered as prime targets.

NONMETALLIC MINERAL RESOURCES

Many of the rocks in the area are potential sources of building and ornamental stone, and although this resource has not been developed, it may represent an important mineral potential of the map area. The wide variety of marble and the Cross Lake plutonic rocks provide a wide range of interesting colours and textures that may prove to be marketable in large urban centres. Most of these rocks are well exposed and are located near major highways leading to the potential markets.

Except for sand and gravel presently being utilized, the other nonmetallic mineral deposits in the area appear to have little or no economic potential; although some of the tremolite accumulations in conjunction with the large

amounts of quartzite and pelitic schist of the Bishop Corners Formation may be worth consideration as a source of muscovite mica.

SAND AND GRAVEL

Local pits of sand and gravel have been worked throughout the area. Large outwash plain deposits are found in the area of Kring Lake in the northwest part of the map area, where several pits are currently being worked by local operators. Large accumulations of sand and gravel in a kame and kettle terrain are operated south of Palmerston Lake.

ROCKS AND MINERALS FOR COLLECTORS

The map area hosts a variety of rocks and minerals that may be of interest to mineral collectors.

The pegmatite dikes (units 14a, 14b) locally contain molybdenite, muscovite, biotite, magnetite, and some also contain well developed graphic intergrowths of quartz and feldspar. Crystals of tourmaline are found in the pegmatite dikes along the northern contacts of the Flinton Group metasedimentary rocks on Lot 31, Concession II, Clarendon Township and Lots 24 and 25, Concession II, Palmerston Township.

The carbonate metasediments host well developed crystals and crystal aggregates of the tremolite-actinolite series in a variety of colours ranging from white through pale green to dark green. Also, diopside may be found in the above association. The abandoned marble quarries along Highway 506, east of the village of Plevna, and adjacent areas, are worth visiting for the above mentioned assemblages.

Some of the felsic metasedimentary gneisses and mafic gneisses contain good crystals of garnet.

The muscovite-biotite schists (unit 11a) outcropping in a narrow belt on the northern limb of the Fernleigh Syncline contain large crystals and crystal aggregates of kyanite, and single crystals or penetration twins of staurolite. Mica, garnet, and large porphyroblasts of plagioclase are also found in this association. One of the best and easily accessible exposures is located on Lot 26, Concession XI, Clarendon Township. Fibrous aggregates of sillimanite occur in the same unit northeast of the village of Ardoch.

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